UNIVERSIDADE DE LISBOA

FACULDADE DE FARMÁCIA DA UNIVERSIDADE DE LISBOA

UNIVERSITÀ DEGLI STUDI DI ROMA *LA SAPIENZA*

DIPARTIMENTO DI MEDICINA MOLECOLARE

EEG neurometric indexes in the assessment of mass media campaigns effectiveness:

Application to anti-tobacco Public Service Announcements

Ana Filipa Martins Pereira

MESTRADO INTEGRADO EM CIÊNCIAS FARMACÊUTICAS

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RESUMO

A epidemia mundial do tabaco é uma das maiores ameaças à saúde pública matando atualmente mais de 7 milhões de pessoas e com um aumento previsto até 2030.

O programa MPOWER, elaborado pela Organização Mundial de Saúde em 2008, consiste num conjunto de políticas práticas, rentáveis e completas de controlo do tabagismo. As políticas estabelecidas, abrangem a monitorização do consumo de tabaco e das politicas preventivas; a proteção da exposição ao fumo do tabaco; a oferta de ajuda na cessação tabágica; a informação sobre os riscos associados ao tabagismo; a proibição total da publicidade, promoção e patrocínios dos produtos de tabaco e o aumento dos impostos sobre os produtos de tabaco.

No âmbito de informar sobre os riscos associados ao tabagismo, o programa MPOWER recomenda a utilização de campanhas *mass media* na promoção da consciencialização dos efeitos nocivos do tabaco e dos perigos da exposição passiva; no incentivo à cessação tabágica; no apoio da implementação de ambientes 100% livres de tabaco e na prevenção da iniciação do tabagismo. As campanhas anti-tabagismo têm a capacidade de influenciar diretamente as intenções, decisões e atitudes do fumador relativamente à cessação tabágica e indiretamente através do aumento das discussões interpessoais e da influência nas normas sociais. Consequentemente, o aumento de comportamentos associados à cessação tabágica tem o potencial impacto de diminuir a prevalência de fumadores, bem como o número de cigarros consumidos.

Contudo, vários estudos evidenciam que a eficácia destas campanhas está dependente de quatro fatores: duração e intensidade da campanha; canais *mass media* onde é comunicada; tipos de comunicação utilizados e o público-alvo a que se destina. Atualmente, a má gestão destes fatores e os métodos utilizados para a avaliação da eficácia das campanhas fazem com que apenas uma pequena parte dos investimentos realizados pelos governos tenham o retorno esperado. Os métodos tradicionais que avaliam a eficácia das campanhas baseiam-se em questionários que reportam de forma subjetiva as perceções conscientes do público-alvo, dependendo da vontade e capacidade de expressão do mesmo. Posto isto, torna-se necessária a adoção de uma nova metodologia de estudo que avalie objetivamente o sucesso de uma campanha anti-tabagismo antes que esta seja divulgada e os investimentos tenham sido feitos.

O neuromarketing é um ramo da neurociência que se foca na aplicação de métodos neurológicos e biológicos para avaliar os processos cognitivos, comportamentais e neurológicos resultantes de estímulos de marketing. Uma das técnicas neurométricas mais

utilizadas é o eletroencefalograma (EEG) que efetua medições das variações da atividade elétrica do cérebro através das diferentes ondas cerebrais. Esta metodologia tem como vantagem refletir, simultaneamente ao estímulo, os processos cognitivos e emocionais do público-alvo, fornecendo informações do consciente e inconsciente que contribuem para o sucesso da campanha.

O objetivo deste projeto é validar o eletroencefalograma (EEG) como uma metodologia neurofisiológica objetiva capaz de avaliar a eficácia de campanhas anti-tabagismo através de variações da atividade cerebral. Este estudo também pretende contribuir para uma melhor compreensão dos diferentes tipos de comunicação utilizados. Como tal, o presente estudo utiliza dois índices que refletem as variações da atividade cerebral, a aproximação-rejeição e o esforço mental. Ambos foram aplicados numa amostra populacional de fumadores e não fumadores para a avaliação da eficácia de três categorias de campanhas de serviço público: eficazes, ineficazes e premiadas.

Os resultados comprovam relativamente ao índice aproximação-rejeição, que as campanhas consideradas interessantes (eficazes e premiadas) ativaram o lóbulo frontal esquerdo como consequência de uma diminuição da atividade *alpha*. Em contrapartida, as campanhas consideradas desinteressantes (ineficazes) ativaram o lóbulo frontal direito comparativamente ao esquerdo. Os diferentes resultados neste índice podem ser justificados considerando os tipos de comunicação utilizados. Tendem a ser consideradas mais interessantes pela amostra populacional em estudo as campanhas que estimulam sentimentos negativos no público-alvo, que utilizam temas de mensagem relacionados com a exposição passiva e os riscos associados ao tabagismo e que no seu estilo de produção revelam a presença de crianças ou uma forte componente visual. Contudo, os tipos de comunicação pelo enorme impacto no sucesso da campanha devem ser considerados um foco de futuras investigações. O índice que reflete o esforço mental confirmou que um aumento da atividade *tetha* no lóbulo frontal ocorre quando o participante, aquando da visualização de campanhas de difícil perceção (ineficazes), diminui progressivamente a sua atenção devido à fadiga mental induzida.

Seria interessante, no futuro, realizar o estudo com mais estímulos de marketing, com diversas técnicas de neuromarketing e com uma amostra populacional maior, que refletisse as diferentes condições socioeconómicas e o género dos participantes.

O presente trabalho dá suporte à validação dos índices de neuromarketing para avaliar com objetividade e economicamente a eficácia de campanhas anti-tabagismo, prevendo uma melhor aplicação dos fundos estatais nas campanhas *mass media* anti-tabagismo.

PALAVRAS-CHAVE: Campanhas *mass media* anti-tabagismo; Campanhas de serviço público; Eletroencefalograma (EEG); Neuromarketing; Políticas de controlo do tabagismo.

ABSTRACT

Global tobacco epidemic is one of the biggest public health threats the world has ever faced. Tobacco use kills more than 7 million people a year and this number is projected to increase by 2030. Remarkable progress has been made in global tobacco control since MPOWER was implemented by World Health Organization. In this practical, cost-effective and comprehensive set of tobacco control policies, countries are commanded to use mass media campaigns to promote public awareness about the harmful effects of tobacco use and second-hand exposure; influence the smoker's intentions about quitting; promote free-tobacco policies and prevent smoking initiation. However, high costs are being invested by the governments in anti-tobacco campaigns which only a small part is successfully employed. In addition, the current methods to evaluate the effectiveness of a campaign are based on the will and consciousness of the target to report. Facing this, a new methodology is necessary to ensure the success of an anti-tobacco campaign.

This work intends to validate an objective neurophysiological tool, the electroencephalographic, capable of assessing the effectiveness of anti-tobacco campaigns through brain activity variations. This method reflects the cognitive and emotional processes of the target predicting its effectiveness. Additionally, this project intends to contribute for a better comprehension of the different types of communication used in anti-tobacco campaigns.

The study was performed using two electroencephalographic indexes, approach-withdrawal and mental effort, for the evaluation of the efficacy of three categories of public service announcements (effective, awarded, and ineffective) in an adult sample of heavy-smokers and non-smokers. Concerning the results exposed for approach-withdrawal index, public service announcements considered interesting by the participants activated the left frontal lobe showing a desynchronization of the alpha activity. The mental effort index confirmed that an increase of theta activity in the frontal lobe occurs when the participant has a progressive withdrawal of attention induced by mental fatigue during the observation of public service announcements considered ineffective. The types of communication used for anti-tobacco mass media campaigns have a huge impact in its effectiveness and are work material for future research.

KEYWORDS: Anti-tobacco mass media campaigns; Electroencephalographic (EEG); Neuromarketing; Public Service Announcements (PSAs) and Tobacco control policies.

A quem enche o coração. SEMPRE.

Mãe, Pai
Avós, Padrinho, Minda, Sofia, Tios

A quem caminha lado a lado, segundo a segundo.

Diogo

A quem vê crescer e cresce contigo.

Carlos, Gonçalo, Clé, Duarte

A quem cria momentos e memórias inesquecíveis.

Barbie, Migalhas, Porcelana, Meira, Márcia
Adão, Débora, Madu, Inês

A quem dá um novo significado à palavra *família*.

Rute
Pedri, Simaura
Joana, Inês

A quem ensina a ser farmacêutico.

Doutora Cristina Simões, Doutora Crudélia Alves, Doutor Armando Alcobia

A quem dá a mão.

Professora Doutora Maria Rosário Lobato

A chi dà la mano.

Enrica

Chi traduce *saudade* in italiano.

Catarina
Vera, Francesca, Leyla, Tatiana, Inge, Esther

Muito obrigada.

Grazie mille.

The important thing is not to stop questioning.

Curiosity has its own reason for existing.

- Albert Einstein

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LIST OF ABBREVIATIONS

ANOVA: Analysis of variance

AW: Approach-withdrawal

EEG: Electroencephalogram

EfI: Mental effort

FC: Frontal cortex

FCTC: Framework Convention on Tobacco Control

fMRI: Magnetic Resonance Imaging

GFP: Global field power

GRPs: Gross rating points

HERA: Hemispheric encoding/retrieval asymmetry

HICs: High-income countries

HS: Heavy-smokers

IAF: Individual alpha frequency

IAPS: International Affective Picture System

KPIs: Key performance indicators

LMICs: Low- and middle-income countries

MEG: Magnetoencephalography

MMCs: Mass media campaigns

MSV: Message sensation value

NRT: Nicotine replacement therapy

NS: Non-smokers

PET: Positron Emission Tomography

PFC: Pre-frontal cortex

PSAs: Public service announcements

SHS: Second-hand smoke

TAPS: Tobacco advertising, promotion and sponsorship

WHO: World Health Organization

1| INTRODUCTION

1.1. Global Tobacco Epidemic

Every single death from tobacco use is an avoidable disaster. Globally, tobacco-related deaths amounted 100 million people in the twentieth century. If current trend continue, tobacco epidemic will kill around 1 billion people through this century (1). Tobacco use kills more than 7 million people every year and is projected to increase to eight million tobacco-related deaths annually by 2030, amounting to 10% of annual deaths worldwide, with 80% of deaths occurring in low- and middle-income countries (LMICs) (2,3).

The global age-standardized prevalence of daily smoking is declining from 23,5% in 2007 to 20,7% in 2015 – a reduction in smoking of 2.8% in 8 years. Although the smoking prevalence has decreased since 2007, the major decline has occurred in high-income countries (HICs). Unfortunately, the global decline in smoking prevalence has not translated into a smaller number of smokers. This is because of population growth: while the proportion of the population that smokes has decreased, the number of smokers has not. In 2007, there were 1.1 billion smokers in the world and this number did not change by 2015 (4). If countries maintain tobacco control activities at current levels, it is expected that by 2030 smoking prevalence in LMICs will decline slower than in HICs (Figure 1.1) (4).

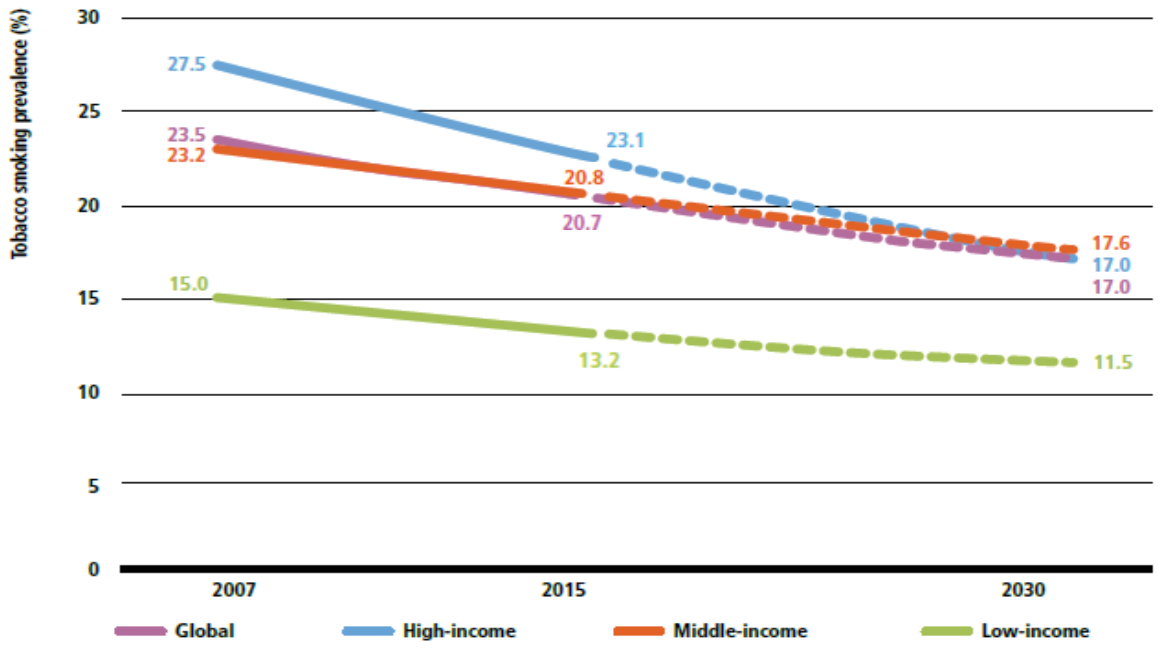

FIGURE 1.1 | Adult tobacco smoking prevalence, 2007–2015, and WHO-estimated, 2030. Ages 15+ (4).

Globally, about 35% of men aged above 15 years old are current smokers. Smoking rates in women have been significantly decreasing in several HICs, nowadays the mean prevalence worldwide is 6%. Nevertheless, smoking among women still more usual in HICs than in LMICs (Figure 1.2) (1,4,5). Most regular smokers initiate smoking before 20 years old. Europe has highest smoking prevalence by adolescents. The average prevalence Europe countries represented is 12% for male adolescents and 11% for female adolescents (6).

Tobacco smoke has more than 7 000 chemicals and at least 69 human carcinogens. The high toxicity of tobacco smoke increases the risk of numerous diseases and disabilities to smokers. Lung cancer is the leading cause of cancer death worldwide and at least 80% of lung cancer deaths are attributable to tobacco use (1,7). It is estimated life expectancy for smokers 15 shorter than for non-smokers (8). Among middle-aged persons, smoking is the leading risk factor for premature death in men and the second one in women. (Figure 1.2) (1).

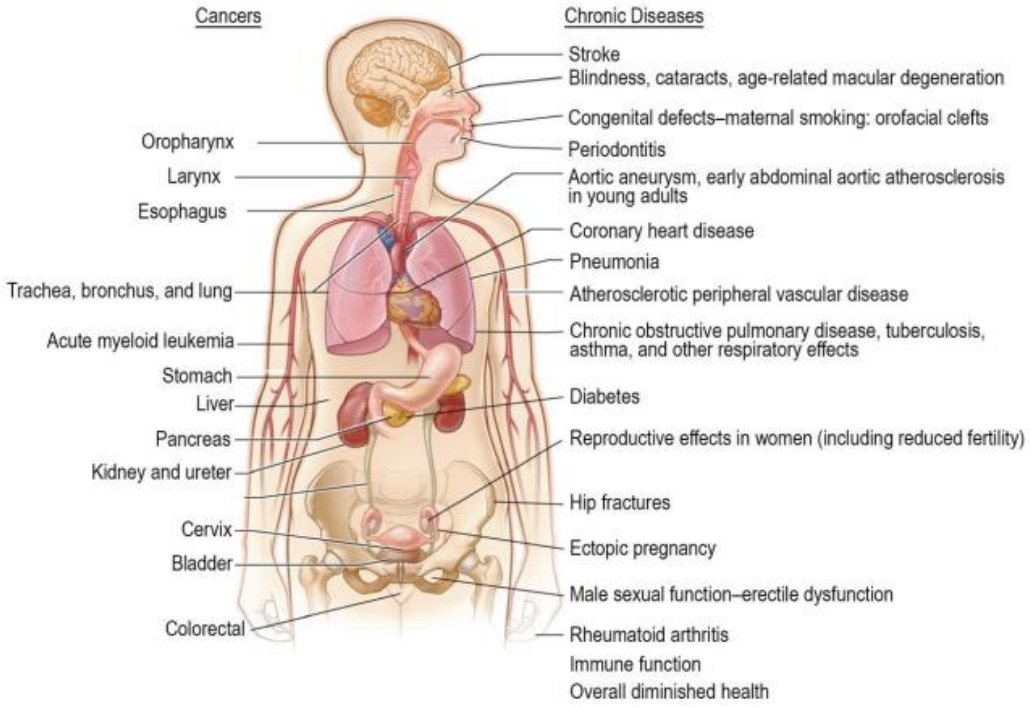

FIGURE 1.2 | Tobacco-related health consequences. Cancers and Chronic Diseases (9).

The smoke involuntarily inhaled by non-smokers is called second-hand smoke (SHS) or environmental tobacco smoke (10). SHS is the smoke emitted from the burning end of a cigarette usually in combination with the mainstream smoke exhaled by the smoker, and has similar components to inhaled or mainstream smoke. Exposure to SHS killed more than 890 000 non-smokers in 2016 (2). Although most health effects of active smoking appear in older ages, many victims of exposure to SHS are children or even unborn babies (Figure 1.3) (1,2,10).

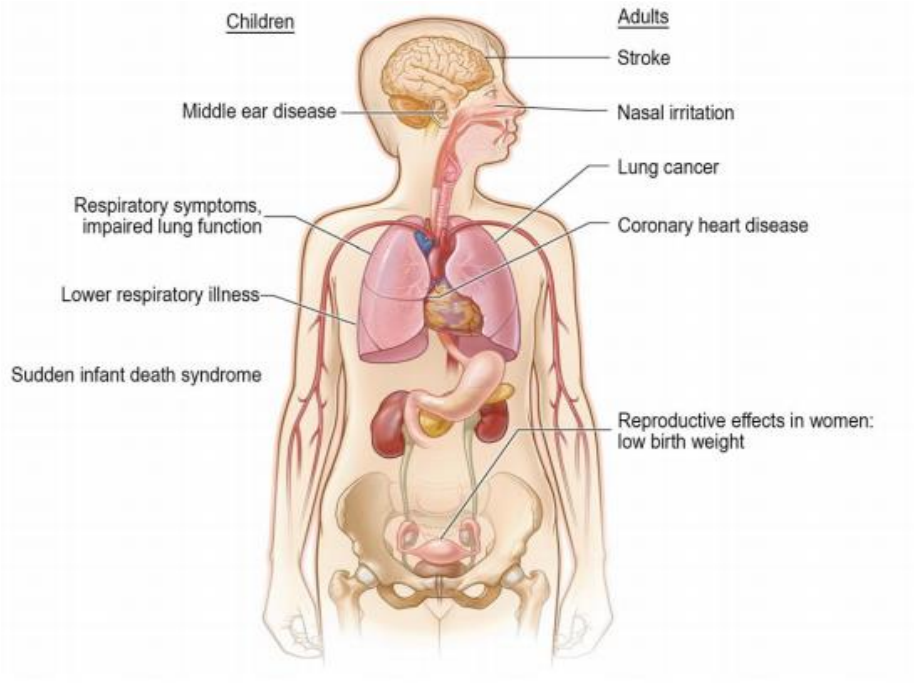

FIGURE 1.3 | Health consequences causally related to second-hand smoke exposure. Children and adults (9)**.**

The health consequences of tobacco use are well known, but less recognized are the significant social and environmental impacts of tobacco production and use.

Tobacco and poverty are inextricably linked in a vicious circle, through which tobacco exacerbates poverty and poverty leads to increased use of tobacco (11). Smoking habit tends to be higher among the poorest segments of the population. Globally, 84% of smokers live in LMICs (12). In these countries, tobacco spending represents more than 10% of total household expenditure leaving less expendable income for basic needs (8). There are some health conditions associated with higher rates of tobacco use - alcohol abuse, mental illness, tuberculosis and acquired immunodeficiency syndrome – that takes workers out of the workforce, adding to the indirect costs of tobacco and creating further downward pressure on the economy, especially in LMICs (1,11).

1.2. Tobacco Control Policies

The tobacco epidemic demands real solutions. On May 2003, the World Health Assembly, the annual meeting of the member countries of the World Health Organization (WHO), adopted the Framework Convention on Tobacco Control (FCTC), that entered into force on 27 February 2005. The WHO FCTC is the first global public health treaty now ratified by 180 Parties covering more than 90% of the world's population developed in response to the globalization of the tobacco epidemic (2). The WHO FCTC is a milestone for the promotion of public health that reaffirms the right of people to the highest standard of health and provides new legal dimensions for international health cooperation (13). To help those countries fulfil their

commitment to the WHO FCTC, in 2008, the WHO introduced a practical, cost-effective and comprehensive set of tobacco control policies known as MPOWER (14).

MPOWER tobacco control requires strong political commitment as well as the participation of civil society, health-care providers and others, to envision a world where no child or adult is exposed to tobacco smoke. The policy package to reduce global tobacco provides complementary and synergistic tools that should be implemented with a high level of coverage to create a world where tobacco use declines by promoting a legal and socio-economic context that favours tobacco-free living. Each MPOWER measure corresponds to one or more articles of the WHO FCTC (2,14).

The six MPOWER measures are:

- **M**onitor tobacco use and prevention policies;
- **P**rotect people from tobacco use;
- **O**ffer help to quit tobacco use;
- **W**arn about the dangers of tobacco;
- **E**nforce bans on tobacco advertising, promotion and sponsorship;
- **R**aise taxes on tobacco (Table 1.1) (4).

MPOWER	Interventions	WHO FCTC articles
Monitor tobacco use and prevention policies	▪ **M1:** Obtain nationally representative and population based periodic data on key indicators of tobacco use for youth and adults.	Article 20
Protect people from tobacco use	▪ **P1:** Enact and enforce completely smoke-free environments in health-care and educational facilities and in all indoor public places including workplaces, restaurants and bars.	Article 8
Offer help to quit tobacco use	▪ **O1:** Strengthen health systems so they can make tobacco cessation advice available as part of primary health care. Support quit lines and other community initiatives in conjunction with easily accessible, low-cost pharmacological treatment where appropriate.	Article 14
Warn about the dangers of tobacco	▪ **W1:** Require effective package health warning labels. ▪ **W2:** Implement anti-tobacco mass media campaigns.	Article 11 Article 12
Enforce bans on tobacco advertising, promotion and sponsorship	▪ **E1:** Enact and enforce effective legislation that comprehensively bans any form of direct or/and indirect tobacco advertising, promotion and sponsorship.	Article13
Raise taxes on tobacco	▪ **R1:** Increase tax rates for tobacco products and ensure that they are adjusted periodically to keep pace with inflation and rise faster than consumer purchasing power. ▪ **R2:** Strengthen tax administration to reduce the illicit trade in tobacco products.	Article 6

TABLE 1.1 | Policies and interventions of the MPOWER package. Correspondence with WHO FCTC articles (4,14).

Extraordinary progress has been made in global tobacco control since MPOWER was introduced a decade ago. In 2016, about two thirds of countries have introduced at least one MPOWER measure at the highest level of achievement (not including Monitoring or Mass media campaigns) - covering 63% of world's population (Figure 1.4) (4).

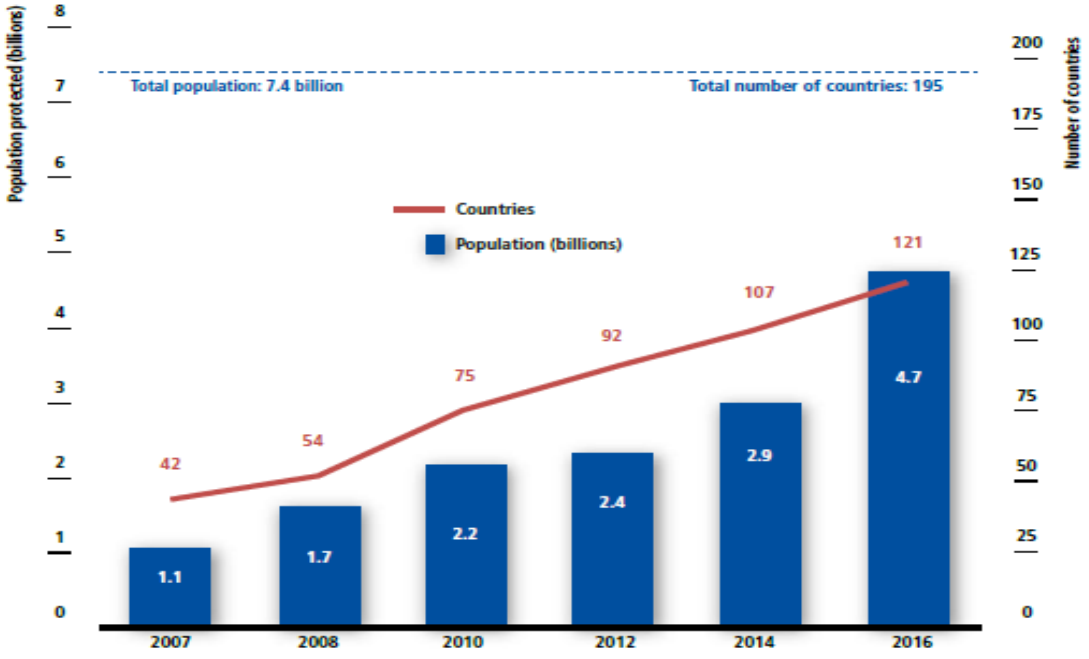

FIGURE 1.4 | Progress in at least one selected tobacco control policy at highest level of achievement, 2007-2016. Total population and number of countries (4).

1.2.1. Monitor tobacco use and prevention policies

Robust national and international monitoring systems are essential components to understand the trends in tobacco use and exposure to tobacco smoke, and to plan effective tobacco control policies and interventions (14). Tobacco monitoring should be an ongoing and long-term process that must be well-planned and regularly conducted to allocate the adequate resources in accordance with the needs of different population subgroups (4).

Any monitoring system must use standardized and scientifically valid data collection and analysis practices to keep data comparable even when collected at different times, by different authorities and systems. An effective monitoring system should also be simple, flexible to adapt new information, representative of the general population as much as possible, periodic with regular intervals, timely between data collection and availability of results, sustainable and usable to take appropriate action (4,15).

Monitoring of tobacco control policies can comprise a range of activities, including: assessing the strength of existing policies against best-practice criteria (WHO FCTC requirements and guidelines for tobacco control policies); identifying potential gaps in existing policies and

legislation; monitoring any tobacco industry activities that may interfere with new or existing policies and outlining areas for improvement. Countries adopting MPOWER package need to evaluate the effectiveness of all and each existing tobacco control policies and identify areas that need further consolidation to have a highest impact in tobacco epidemic (Table 1.2) (4).

	Indicator and description
Monitor	▪ **Current tobacco users** Percentage of respondents who currently use any tobacco products (smoked and smokeless) ▪ **Current tobacco smokers** Percentage of respondents who currently smoke any tobacco products ▪ **Daily tobacco smokers** Percentage of respondents who currently smoke tobacco products daily ▪ **Current smokeless tobacco users** Percentage of respondents who currently use smokeless tobacco ▪ **Daily smokeless tobacco users** Percentage of respondents who currently use smokeless tobacco daily
Protect	▪ **Exposure to second-hand smoke at home** Percentage of respondents who report that smoking occurs inside their home ▪ **Exposure to second-hand smoke at work** Percentage of indoor workers who were exposed to tobacco smoke at work in the past 30 days ▪ **Inspections of designated smoke-free places** (including worksites and indoor public places) Percentage of places where regulation is complied
Offer	▪ **Tobacco use quit attempt in the past 12 months** Percentage of current tobacco users who tried to quit during the past 12 months ▪ **Health care provider's advice to quit using tobacco** Percentage of current tobacco users who visited a doctor or health care provider during the past 12 months and were advised to quit tobacco use
Warn	▪ **Awareness of anti-tobacco information in newspapers or magazines** Percentage of respondents who have noticed information about the dangers of tobacco use or that encourages quitting in newspapers or magazines in the last 30 days ▪ **Awareness of anti-tobacco mass media communication on television** Percentage of respondents who have noticed information on television about the dangers of tobacco use or that encourages quitting in the last 30 days ▪ **Noticing health warning labels on tobacco packages** Percentage of current tobacco users who noticed health warnings on tobacco packages in the last 30 days ▪ **Thinking of quitting because of health warning labels on tobacco packages** Percentage of current tobacco users who reported thinking about quitting tobacco use in the last 30 days because of the warning labels on tobacco packages or mass media communication
Enforce	▪ **Awareness of tobacco advertising in stores** Percentage of respondents who have noticed any advertisements or signs promoting tobacco products in stores where tobacco products are sold in the last 30 days ▪ **Awareness of specific types of tobacco promotions** Percentage of respondents who noticed (free samples of tobacco products, tobacco products at sales prices, coupons for tobacco products, free gifts or discounts on other products when buying tobacco products, clothing or other items with a tobacco product brand name or logo, tobacco product promotions in the mail) in the last 30 days ▪ **Inspections of retail locations** Percentage of places where restrictions on product displays, point-of-sales, advertising, and sales minor is complied ▪ **Inspections of print and broadcast media** Verify bans on advertising, promotion and marketing

Raise	▪ **Cost of manufactured tobacco products** Average amount spent on a pack of manufactured tobacco products (in local currency) ▪ **Tobacco product affordability** Average cost of 100 packs of manufactured tobacco products as a percentage of gross domestic product per capita

TABLE 1.2 | Monitoring MPOWER measures (4)**.**

Around 39% of the world's population in 76 countries is protected by strong, full-scale monitoring systems for both adults and youth (Figure 1.5). More than 70% of HIC are adequately monitoring tobacco use among both adults and youth (4).

1.2.2. Protect people from tobacco use

The only tobacco control intervention shown to fully protect the health of people from the harmful effects of SHS is establishing environments that are 100% smoke-free because no level of exposure is acceptable (4). Measures intended to accommodate smoking, such as designated smoking rooms and ventilation techniques, do not prevent exposure to SHS because they cannot effectively eliminate all the smoke (1,4).

Effective smoke-free laws have neutral or positive financial impact on businesses and invariably achieve overwhelming public support even among tobacco users, this support tends to increase over time after these policies are in place. Support is generally stronger for healthcare facilities rather than nightclubs. Legislation mandating smoke-free public places also encourages people to make their homes and automobiles smoke-free (4,16).

Comprehensive smoke-free legislation is in place for almost 1.5 billion people in 55 countries - 20% global population coverage in 2016 (Figure 1.5). Since 2007, progress in adopting smoke-free laws has been particularly impressive in LMICs (4).

1.2.3. Offer help to quit tobacco use

WHO recommends at minimum three primary cessation interventions to give support to smokers who want to quit: cessation advice incorporated into primary and routine health-care services; easily accessible and free telephone help lines (quit lines); and access to free or low-cost cessation pharmacological therapy (4).

Health-care systems should encourage all health professionals to routinely ask all patients about their tobacco use and provide advice about the risks of tobacco use and the importance of quitting. Cessation advice and counselling can be most effective when staff take proactive measures to make regular intervals follow-up calls after initial contact to check on progress and provide encouragement to quit or maintain abstinence. The highest quit rates are achieved when cessation support is mutual with pharmacological therapy. Clinical cessation treatment should include at least some form of nicotine replacement therapy (NRT) available over-the-

counter without medical assessment or prescription at retail pharmacies. Each country should include NRT in its Essential Medicines List (4,17).

Comprehensive cessation interventions are in place in 26 countries for 2.4 billion people – 33% of world's population (Figure 1.5). However, this is the most under-used of the MPOWER measures in terms of the number of countries achieving best-practice level (4).

1.2.4. Warn about the dangers of tobacco

People have a fundamental right to access their health information, including receiving correct and comprehensive information about the harms of tobacco use to theirs and other's people health. The two key ways to communicate the health risks of tobacco are effective warning labels and anti-tobacco mass media campaigns (MMCs) (4).

Effective health warning labels deliver important health messages directly to tobacco users which raise awareness of tobacco health dangers and increases the chance to reduce or quit tobacco use. The risks of smoking and SHS exposure are also communicated to non-smokers, keeping young people from starting. Large graphic warning labels are more effective in raising awareness and changing behaviours than smaller warnings or those that contain text-only warnings (4). Article 11 of the WHO FCTC requires that health warnings labels on tobacco packaging follow to explicit features (13,18).

Although, evidences suggest that standardized tobacco packaging is more successful by reducing the attractiveness and marketing effect of tobacco packaging. Plain packaging restrict or prohibit industry logos, colours, images and promotional information and substitute them for uniform fonts and colours schemes that enhance the impact of health warnings (19). Currently, graphic warnings have been adopted by 47% of the global population reaching almost 3.5 billion people in 78 countries (Figure 1.5) (4).

Mass media campaigns are addressed in the next chapter.

1.2.5. Enforce bans on tobacco advertising, promotion and sponsorship

Each year, the tobacco industry spends a lot of money on tobacco advertising, promotion and sponsorship (TAPS) with the primary purpose of continually grow tobacco sales and industry incomes. TAPS activities normalize tobacco, increasing its social acceptability and encouraging smokers to continue and non-smokers to start using, particularly youth and women in LMICs (20).

Effective bans cover direct advertising in all types of media and all forms of indirect TAPS. Bans on point of sale advertising and in-store displays of tobacco products lead to reductions in youth smoking prevalence and impulse purchases among adults wanting to quit (4,21). Partial TAPS bans or prohibitions that are not vigorously enforced have little or no effect on

tobacco use prevalence. When confronted with incomplete bans, the tobacco industry focusses its efforts and financial resources on other permitted types of marketing and promotion activities that are permitted to compensate (20).

Banning TAPS remains an under-adopted measure, with only 37 countries practising comprehensive TAPS bans, although just 22 have high compliance rates – covering 15% of world population (Figure 1.5) (4).

1.2.6. Raise taxes on tobacco

Raising taxes that result in higher tobacco product prices are among the most effective and cost-effective tobacco control measures available. Tobacco taxes are especially effective in preventing or reducing tobacco use among young and lower-income groups. In HICs, a 10% increase in the retail price of cigarettes will reduce consumption by about 4%. In LMICs, the effect is expected to be larger, reducing by about 5% (22).

Nearly all countries tax tobacco products, levying excise taxes, value added tax, general sales taxes, duties on imports, and/or other special taxes. Tobacco excise taxes are mainly important since they apply exclusively to tobacco products and raise their prices relative to prices for other goods and services (5,22). Although the advantages of specific excise taxes, their real value will be eroded by inflation unless they are periodically adjusted with *per capita* income and consumer purchasing power over time (4).

Raising taxes on tobacco products is the least-achieved MPOWER policies with only 10% of world's population protected – covering 32 countries in 2016 (Figure 1.5) (4).

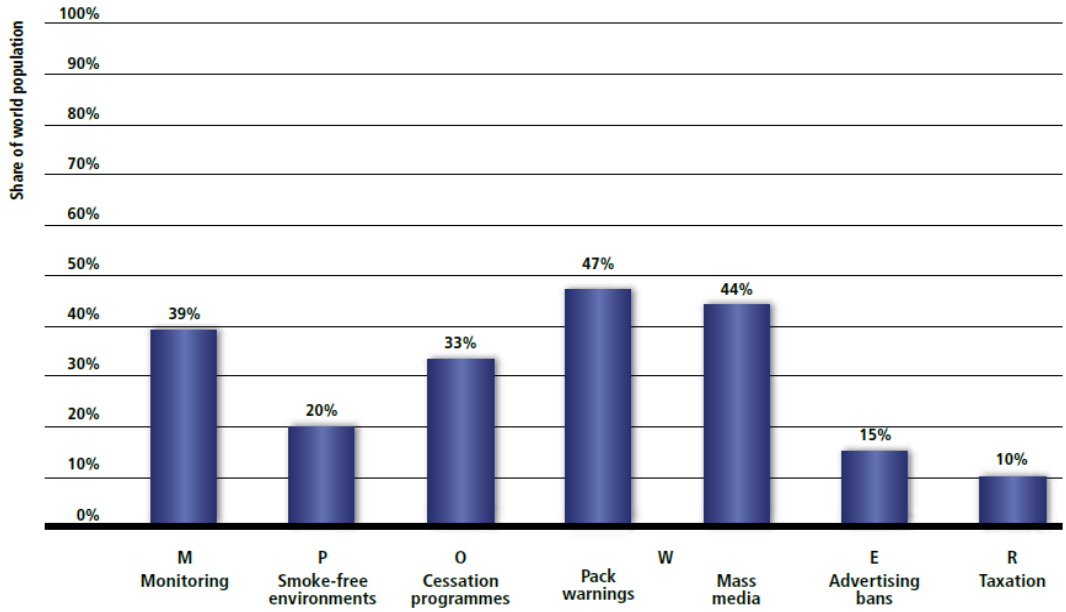

FIGURE 1.5 | Percentage of world population covered by selected MPOWER measure, in 2016 (4).

1.3. Anti-tobacco Mass Media Campaigns

For years, the tobacco industry used mass media to present smoking as an attractive and socially-desirable behaviour. Now the WHO FCTC mandates countries to use mass media, to promote public awareness about the harmful effects of tobacco consumption and exposure to tobacco smoke and promote quitting by providing information on how to obtain support to quit. Mass media encompasses journalistic reporting and commentary, entertainment programming and paid or public advertising and promotion in television, radio, internet, newspapers and magazines (19). Anti-tobacco mass media campaigns (MMCs) are an important part of tobacco control policies due to their potential impact by decreasing cigarette consumption and smoking prevalence and increasing quitting-related behaviours. MMCs can influence directly smokers' decision, attitudes and intentions about quitting and indirectly by increasing interpersonal discussion and influencing social network norms to change smoking behaviour of groups (23).

More countries start to use anti-tobacco MMCs every year, but there is still a large world's population (18%) living in countries that had not aired recently at least one anti-tobacco MMC. Around 3.2 billion people (44% of world population) were exposed to at least one comprehensive national anti-tobacco MMC in the past 2 years. Progress is being made since 2010, the first year MMCs were monitored, with the number of countries applying the best-practise MMC increased from 35 to 32 in 2016. More than half of the LICs (58%) had not aired any kind of MMC in the past 2 years (Figure 1.6) (4).

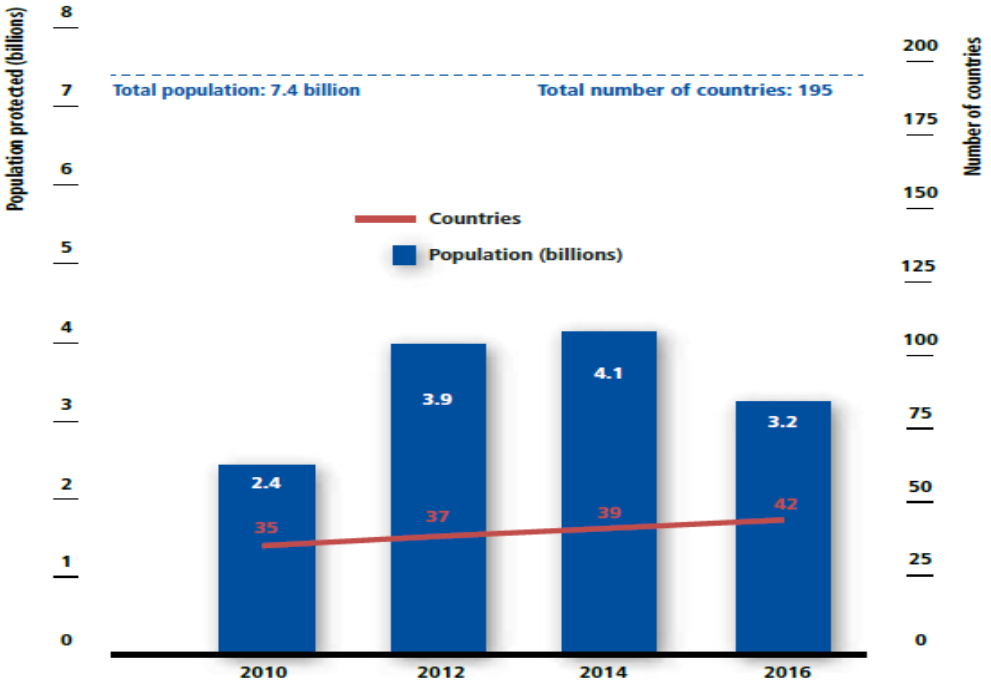

FIGURE 1.6 |Progress in anti-tobacco mass media campaigns, 2010-2016. Total population and number of countries. (4)

Existing guidelines recommend an investment in anti-tobacco MMCs by the governments of HICs of $0,65–1,05 per person per year (23). Countries need to secure sustainable funding for MMCs. The WHO suggest that governments charge tobacco industry for the MMCs costs, dedicate tobacco tax revenues to MMCs and implement free airtime dedicated to MMCs in national mass media (4). Economic evaluation is necessary to understand whether the public health benefits of implementing MMCs are enough to justify the expenditures. Economic evaluation includes the identification, measurement and estimation of costs and benefits of MMCs, generally calculated by the net cost per life-year saved and the net cost per quality-adjusted life year (QALY) gained. In simulation studies, MMCs considered effective have a low cost *per capita* contributing to considerable cost savings in cases of diseases and premature deaths avoided and healthcare cost saved (23,24).

Several evidences suggest that not all MMCs are equally successful and the following factors are likely to determine overall impact and influence the MMCs effectiveness:

- duration and intensity,
- media channels,
- types of communication, and
- target: smokers or non-smokers (25) (26).

1.3.1. Duration and intensity

A significant aspect of determining optimal investment and predict the effectiveness of a MMC is campaign decay, which means the extent time that campaign's effects are detectable after the campaign broadcast ends. A time-series analysis of MMCs exposure data found the impact of MMCs on smoking prevalence lasted only up 2 months after exposure. In addition, their impact on quit attempts lasted 3 months. These results conclude the short-lived effects of MMCs and recommend long-term MMCs exposure for sustained smoking behaviour change (25,26).

MMC intensity is measured in gross rating points (GRPs), a standard advertising industry measure of campaign reach multiplied by frequency that estimates of how often total media market has in theory been exposed to a campaign (27). A recent guideline considered 1200 GRPs per quarter (100% of people within a region exposed to an advertisement 12 times) for a total of 4800 GRPs per year are needed to achieve smoking population changes by efficiently reduce adult smoke prevalence at least in HICs. In England, a study found a 1% increase in GRPs can raise the national quite line calls by 0,085% (26). Adults require a longer MMCs exposure than younger to influence their smoking behaviour, since most adult smokers are vulnerable by addiction (25).

1.3.2. Media channels

Recent studies have examined the relative effectiveness of different advertising channels used by MMCs. After analysis of 47 anti-tobacco MMCs was concluded that 98% used television, 94% radio, 91% sponsored smoking cessation websites, 89% print and 87% billboards. When planning a MMC is necessary to research and select media channels carefully based on the target audience's preferences and cost-effectiveness channel. Among tobacco users, television and radio are the higher exposure channels (25,28).

The most cost-effective MMCs are aired in television, although is difficult to determine if the reduced effectiveness of non-televised MMC is due to the channel, to lower population reach, or to differences in the type of MMCs. Despite radio represents lower costs and reach less population, can be considered a good reinforce adjunct to television by bringing to tobacco user's mind the images associates with the televised campaign (25). Digital media channels (emails, websites, social media, banner advertising) have potential to enhance the reach and cost-effectiveness of anti-tobacco MMCs because of their appealing advantages such as anonymous users, handle a virtually unlimited volume of participants and repeated use, are available 24 hours per day and able to tailor information to audience's needs and preferences and encouraging audience response and discussion (28).

1.3.3. Types of communication

The type of communication of MMCs differ in message theme, production style and emotional content (25,26). Message theme can be perceived as the informational content of the MMCs, focusing on the various approaches to the tobacco epidemic. Message theme reflects the different purposes of the MMCs message, such as providing information about the effective methods of tobacco cessation, the negative health effects of smoking, the positive consequences of smoking cessation, the exposure to SHS (especially those closest to the smoker or children), the manipulative and dishonest tobacco industry and the social acceptability of smoking (29). Production style are the different methods of producing the visual and sound content of MMCs to effectively communicate the message purpose. Production style include acted scenes, testimonial of ex-smokers or celebrities, strong image component (including visual depictions of evidence such as graphics or images of diseased body parts), ironic/humour scenes, medical information and/or simulation and the presence of children in the MMCs. Emotional content reflects the feelings created during or after observation of MMCs. The emotional tone of the target can be negative about smoking generating or not *fear arousing appeal* (arouse fear in to divert behavior through the threat of health risks or dangers of smoking) or positive about tobacco cessation (Table 1.3) (25,26).

Types of Communication	**Message Theme**	▪ How-to-quit ▪ Negative health effects of smoking ▪ Positive consequences of smoking cessation ▪ Exposure to SHS/Paternalistic ▪ Anti-industry ▪ Social norms
	Production style	▪ Acted scenes ▪ Testimonials ▪ Strong image component ▪ Ironic/Humour ▪ Medical information and/or simulation ▪ Child featured
	Emotional content	▪ Negative feelings about smoking ▪ Negative feelings: fear arousing appeal ▪ Positive feelings about quitting

TABLE 1.3 | Framework for categorization of different types of mass media communication (25,26)**.**

There is good evidence that arousing emotion can increase the effectiveness of an anti-tobacco MMC. Messages which elicited strong negative emotions by describing the negative health effects of smoking for individual and/or family or friends are perceived to be more effective, higher in memorability and generate more interpersonal discussion while messages that do not active strong negative feelings but simply present the negative consequences of smoking might not be effective (25,27,30). Testimonials and strong image component campaigns, which tend to contain negative health effects messages and high emotional content, are most effective at increasing quit rates (27).

How-to-quit, anti-industry, positive consequences of smoking cessation and social norms messages were found to be less recalled and appealed (26). In addition, social norms and anti-industry messages can influence young adolescents and more sophisticated people smoking believes, respectively (30). According to WHO, MMCs targeted to adults can be equally effective among young adolescents, however the opposite was shown to be ineffective (19). Although, other evidence suggests negative feelings that arouse fear appeals are not effective for youth because young people view death and disease as long-term concerns. In a large population study, ironic/humour campaign with emotional content positive in valence was found to be less effective than a negative health effects campaign (19,31). However, it is not clear whether how-to-quit, anti-industry and ironic/humour campaigns which arouse high negative emotion levels could be effective or not since is known that negative content tends to produce higher levels of arousal than does positive content.

Message sensation value (MSV) is a specific stylistic feature of a MMC regarding its audio, visual and message content that elicit sensory, affective and arousal responses. The sensation value of MMC depends on the sensation seeking of the target. Since sensation seeking is a

risk factor for smoking, is predictable that most of the target is high in sensation seeking and is necessary high MSV to intensify smokers appraisal to anti-tobacco MMCs (32).

1.3.4. Target: smokers or non-smokers

A recent study has analysed the differences in anti-tobacco MMCs ratings between smokers and non-smokers and was demonstrated non-smokers tend to be more positive in their ratings than smokers. Classically, non-smokers are supporters for tobacco control policies and it is consequently consistent that they would respond more positively to MMCs that encourage their protection from the harmful effects of tobacco use. However, this evidence suggests the mechanisms for behaviour change may be similar for non-smokers and smokers and the same anti-tobacco MMC can be used to influence both the smoking habits. This pattern of findings can be very cost saving since would not be necessary to develop different campaigns for smokers and non-smokers in order to increase smokers' intent to quit and reduce SHS, and increase non-smokers' goals to avoid being exposed to SHS and prevent them of smoking initiation (33).

Another point that influence the effectiveness of an anti-tobacco MMCs is the psychological characteristics of the smoker. Consisting of communication concepts, the smoking history and motivation to tobacco cessation of a smoker influence the MMC processing. In a recent study, all the types of anti-tobacco MMCs were found to be less effective among smokers who have less desire to quit, have not tried to quit in the past year and smoke 20 or more cigarettes per day (25).

1.4. The Potential of Neuromarketing

Every year, millions of euros are invested by governments in anti-tobacco MMCs. To know in advance the potential effectiveness of a anti-tobacco campaign, can save relevant economic support from the Ministers of Health worldwide. The traditional methods used by marketing for predicting the success of a MMC are based on self-reports, focus groups and market tests that rely on the ability and willingness of the subject to report their preferences, behaviours, emotions and attention on the MMC observed (34). The information processed beyond the level of human consciousness and subject's emotional experiences related to the MMC are complex and difficult to understand and express by the traditional methods. When a MMC message theme is sensitive or not social accepted, the subject tends to transmit incorrect information influencing the results (35).

In the past few years, the application of neurophysiological methods to evaluate the effects of marketing stimuli has been studied by scientists. Neuroscience studies the neural mechanisms and brain areas behind cognitive, behavioural and emotional processes. Neuromarketing is a

branch of neuroscience that uses neurological and biological methods to evaluate the effect of a marketing stimuli in emotions, decision making, memory, reasoning etc. (35,36). Neuromarketing tools promise to reveal hidden processes in the subject's *black box*, with accurate neurological responses collected simultaneously at the stimuli. Consequently, it is possible to evaluate previously the MMCs and help governments and marketers to select the images, phrases, sounds and scenes more memorable and appealing creating effective anti-tobacco MMCs capable of changing target's smoking behaviour or preventing smoking initiation avoiding the expensive mistakes (37). The adoption of a multi-method approach combining neuromarketing and traditional methods has been recommended (38).

Neuromarketing methods comprise biometrics and neurometric techniques. biometrics techniques include skin conductance, heart rate, respiration, eye tracking and facial and body expressions. Neurometric techniques measure the functional activity of specific regions of the brain by the analysis of electric brain waves, cerebral metabolism, or/and its blood flow. The most common tools used are Magnetic Resonance Imaging (fMRI), Positron Emission Tomography (PET), Magnetoencephalography (MEG) and Electroencephalogram (EEG) (35,38).

EEG is a central nervous system measurement that records scalp electrical activity of the brain structures. The EEG measure brain waves, repetitive electrical activity in the central nervous system, that are classified according to their frequency, amplitude as well as the spots on the scalp at which they are recorded. The most usual classification system is according to frequency: delta (1 to 4 Hz), theta (4 to under 8 Hz), alpha (8 to 13 Hz), beta (14 to 30 Hz) and gamma (30 to 70 Hz) (35). The advantages of EEG are numerous compared to other techniques: high temporal resolution of milliseconds, high safety and non-invasive, less expensive and portable device with the capacity to measure continuously (37). The principal disadvantage of EEG is its limited spatial resolution that produces low sensibility to subcortical generators form scalp surface. Although, scientists are improving the spatial resolution by increasing the number of electrodes and developing powerful processing and analysing systems (35).

Neuromarketing studies are seeking to identify brain regions and frequency brain waves connected to different emotional and cognitive responses induced during the visualization of MMCs. Emotional response is organized in 3 dimensions: valence (positive or negative), arousal (low or high) and approach-withdrawal. Evidence from EEG studies indicate the anterior cerebral hemispheres are oppositely lateralizes for approach-withdrawal tendencies with de-synchronization of the alpha activity. Approach-withdrawal can be measured by the variations of pre- and frontal cortex (PFC and FC). The PFC and FC are brain structures responsible for a wide variety of functions such as coordinating complex behaviour, control

and organization of emotion responses, personality, focusing and decision of choice (39). The left PFC is involved on motivation approach behaviour while the right PFC mediates defensive withdrawal. The activation of left PFC is reflected by reduced alpha activity (inverse of cortical excitability) and indicates tendencies to approach the stimuli. In this context, it is expected to increase left PFC activation and reduce alpha activity in the left side for effective anti-tobacco MMC stimuli (36,40). Some findings suggest that memorization and emotional responses of content in a MMC are correlated, hemispheric encoding/retrieval asymmetry (HERA) model suggest the left PFC is involved during the encoding phase of information from short memory to long memory, while right PFC plays a role in retrieval the information (35,41).

The frontal areas are involved in cognitive responses such as attention and, mental effort and fatigue (42). Mental effort is a measure of mental capacity allocated to a specific task and is affected by mental fatigue. Mental fatigue reflects the unwillingness of alert and cognitive dysfunction with decrease of vigilance when performing a task (43,44). When a subject has high mental fatigue a decline of cognitive performance and arousal is noticed which leads to progressive withdrawal of attention and, consequently, to deficient information processing and working memory (44,45). The EEG power spectra during this phenomenon increase in theta activity. This augment in the PFC theta activity indicate a counterbalance mechanism by recruiting more cognitive resources to combat the decline in task performance induced by mental fatigue (43). High theta activity is associated with performing difficult tasks that require focused attention or time pressure.(43) In the anti-tobacco MMCs context, it is expected effective MMCs cause less mental fatigue and consequently reduced theta activity.

Neuromarketing studies can provide interesting indications about the effectiveness of different scenes of a MMC by objectively measure cognitive and emotional variables (42).

2| AIM OF THE PROJECT

Facing the high costs invested by the governments in anti-tobacco MMCs in which only a small part of the campaigns is successfully produced and the precarious and subjective market study methods to determine the effectiveness of a campaign, the validation of new objective and reliable methods to ensure the effectiveness of campaigns is strongly needed.

The overall goal of this project is to contribute to the validation of a neuroscientific tool, the brain indexes obtained by EEG, which reflect cognitive and emotional processes, as an objective methodology capable of assessing the effectiveness of anti-tobacco MMC. In addition, this project intends to contribute for a better comprehension of the different types of communication used in anti-tobacco MMCs and how they influenced the effectiveness of a campaign among heavy-smokers and non-smokers.

The validation of the methodology of this project can contribute to the development of effective and sustainable anti-tobacco MMCs with a favourable cost-benefit ratio and, consequently, to support established anti-tobacco policies with the aim of controlling global tobacco epidemic.

3| MATERIALS AND METHODS

This study describes the results of cerebral neurometric indexes for the evaluation of the effectiveness of Public Service Announcements (PSAs) in a sample of voluntary adult's participants divided in two groups: non-smokers and heavy-smokers. The neurometric indexes employed are approach-withdrawal (AW) and mental effort (Efl) and are calculated from EGG rhythms variation during the visualization of effective, ineffective and awarded PSAs (46).

3.1. Participants

The recruitment of participants was accomplished in Sapienza University Campus, Rome, Italy among students and employees. For inclusion into the study, participants were screened with a self-report questionnaire and were required to be in good physical health with no current medical illnesses, be medication-free and to have no psychiatric or neurological history. 38 participants (22 males, 16 females) aged 25-55 years old (M=37,053; SE=±1,578) have been recruited for this study. Concerning smoking habits, 19 participants are heavy-smokers (HS) and 19 participants are non-smokers (NS) (Annex I). *Smoking* was classified as anything with nicotine content, including pipes, cigars and chewing tobacco. HS are considered the tobacco users that smoke more than 5 cigarettes per day. NS are participants who have smoked less than 10 cigarettes in their lifetime and none in the past year. All participants received detailed information about the project and signed an informed consent. The study is in accord to the principles delineated in the Declaration of Helsinki of 1975, as revised in 2000, and it was approved by the Sapienza University Ethical Committee (46).

3.2. Public Service Announcements and Baseline Selection

PSAs selected for this study are short, non-commercial mass media campaigns that provide information and modify public behaviour. A non-commercial campaign intends to benefit its target, rather than the company that developed it. PSAs are at the core of many public health and behaviour campaigns against smoke, abuse of alcohol, drug addiction and other possible threats for the health of citizens. In this study PSAs, videos and images, are classified into: effective, ineffective and awarded (41).

- **Effective:** PSAs which promoted a measurable improvement of public health, (quit-line recourse, against smoking services use, national investment funds saving, as stated by literature, official reports, and institutional websites);
- **Ineffective:** Those PSAs resulted useless for the population, or even promoting pro-smoking behaviours, as stated by literature, official reports, and institutional websites;

- **Awarded:** PSAs which received specialized national or international awards for: the creativity, the innovative character, the impact, the design, the copywriting, the use of media and the memorability. (47)

For the classification of PSAs, key performance indicators (KPIs) were designed based on the propose of Coffman (48) and Varcoe (49). Each PSA was given a score from -3 to +3 for each KPI item to rank them hierarchically, selecting those which obtained the higher (effective) and lower (ineffective) absolute scores. The awarded PSAs were selected based on the numbers of awards gained. The table 1.4 show the 10 PSAs selected (Annexes II and III) (50).

PSAs Classification	Name	Country	Year	Total score	Number of awards
Effective	*Bubble wrap*	Australia	2000	+5	-
	Smoking kid	Thailand	2012	+3	-
	Help.eu	European Union	2005-2008/ 2009-2010	+3	-
	CDC Roosevelt	United States of America	2012-2015	+15	-
Ineffective	*Feel free to say no*	European Union	2003	-3	-
	Think. Don't smoke	United States of America	1998	-4	-
	Tobacco is wacko	United States of America	2000	-3	-
Awarded	*Fatty cigarettes*	United Kingdom	2003	-	8
	Baby love	Finland	2013	-	3
	Breath holder	Finland	2014	-	3

TABLE 3.1 | Classification into effective, ineffective and awarded public service announcements. Name, country and year aired on mass media. (50)

PSAs were insert into a database to categorized them independently by coding the influencing factors of the type of communication: message theme, production style and emotional content (Table 3.2) (25,26).

PSAs		Coding	Description
Effective	*Bubble wrap*	**Message Theme:** Negative health effects **Production style:** Strong image component **Emotional content:** Negative feelings: fear arousing appeal	The campaign shows bubble wrap to depict the damage smoking can cause to the lungs, especially about the risk of emphysema even if the smoker uses smoke low tar cigarettes.
	Smoking kid	**Message Theme:** Exposure to SHS/ Paternalistic **Production style:** Child featured **Emotional content:** Negative feelings about smoking	Children carrying cigarettes approached adults in smoking areas. Adults refused and warned the children not to smoke. The children asked the adults why they themselves were smoking and gave them a "quit smoking" brochure.
	Help.eu	**Message Theme:** Social norms **Production style:** Ironic/Humour **Emotional content:** Negative feelings about smoking	Several young people at a party, where smoking disrupts the communication and relationships of them. Campaign for young people and focuses on a tobacco-free environment.
	CDC Roosevelt	**Message Theme:** Negative health effects **Production style:** Testimonial **Emotional content:** Negative feelings about smoking	Featured Roosevelt, an ex-smoker, never thought that at 45-years-old he would have a heart attack due to his smoking. He talks about the impact his smoking-related heart attack has had on his life.
Ineffective	*Feel free to say no*	**Message Theme:** Social norms/ positive consequences of smoking cessation **Production style:** Testimonials **Emotional content:** Positive feelings about quitting	A long list of pop stars sings and say no to tobacco. The campaign focus on young people and how pop stars can prevent smoking among young people by influencing them.
	Think. Don't smoke	**Message Theme:** Social norms **Production style:** Ironic/Humour **Emotional content:** Negative feelings about smoking	The romantic relationship between two young people ends when the boy handles a pack of cigarettes and the girl imagines a monkey.
	Tobacco is wacko	**Message Theme:** Social norms **Production style:** Ironic/Humour **Emotional content:** Negative feelings: fear arousing appeal	The campaign shows a comparison between rubbish and tobacco. Several dirty scenes are shown but when a young man lights his cigarette, that is the only scene judged to be disgusting.
Awarded	*Fatty cigarettes*	**Message Theme:** Negative health effects **Production style:** Strong image component **Emotional content:** Negative feelings: fear arousing appeal	To show the damage that smoking does to smokers' arteries, smokers are shown with fatty deposits dripping from the end of their cigarettes. The fatty deposits are disgusting.
	Baby love	**Message Theme:** Exposure to SHS/ Paternalistic **Production style:** Child featured and Ironic/Humour **Emotional content:** Negative feelings: fear arousing appeal	The campaign shows several ways a mother can kill/hurt her own baby. The last hurt is through the act of smoking. The PSA challenge the attitudes and beliefs around smoking during pregnancy, and encourage mothers to quit.
	Breath holder	**Message Theme:** Exposure to SHS/ Paternalistic **Production style:** Child featured and Ironic/Humour **Emotional content:** Negative feelings: fear arousing appeal	The PSA illustrates the child's point of view of passive smoking showing a boy who fights against passive smoking with the only means within his reach: holding his breath.

TABLE 3.2 | Categorization and description of public service announcements.

The selection of the baseline stimuli is a crucial process because baseline is the initial collection of data which serves as a basis for comparison with the subsequently acquired data from the PSAs and help to eliminate the uncontrollable variables, such as the state of the participant (42).

Six images were used as baseline, collected from the International Affective Picture System (IAPS) database and a neutral documentary lasting 1 minute about the space (Annex IV) (50).

3.3. Procedure

The participants were sitting on a comfortable chair, 1 metro in front of a screen, where a series of PSAs were played. The skin in the forehead and ear lobes was cleaned with chlorhexidine antiseptic solution to disinfect and remove the most superficial lipid layer on the skin. An EEG band with 10 electrodes were used in this experiment according to the 10-20 international system. An electrodermal gel was injected to ensure lowering of contact impedance at electrode-skin interface. The reference electrodes were placed one per ear lobe. Was asked to the participant to limit any movement and stay relax (46,49).

FIGURE 3.1 | Cleaning the superficial lipid layer on forehead skin (50)**.**

FIGURE 3.2 | Placing the EEG band with 10 electrodes on the forehead (50)**.**

FIGURE 3.3 | Reference electrode placed in the ear lobe (50)**.**

Was asked to the participant to look for 1 minute to a white cross to measure the resting condition activity, necessary to calculate the Individual Alpha Frequency (IAF) during the EEG pre-processing phase. The experimental protocol is composed by two blocks: one showing PSAs images and the other videos. The 10 images (each lasting 9 seconds) were randomly preceded and followed by 6 baseline images. The 10 randomized PSAs videos were preceded and followed by the documentary used as baseline for videos. To avoid bias of positional effect in the participants' reaction, were created 16 randomized schemas of the movie experience (46,49).

FIGURE 3.4 | Observation for 1 minute of a white cross in the screen to measure the resting condition activity (50)**.**

FIGURE 3.5 | Observation of an anti-tobacco public service announcement (50)**.**

3.4. Electroencephalographic Recordings and Signal Processing

The cerebral activity was recorded by means of a portable 24-channel system (BEmicro, EBneuro, Italy). The EEG activity was collected at a sampling rate of 256 Hz while the impedances were kept below 10kΩ. Each EEG trace was then converted into the EEGlab format, running under the cross-platform MATLAB (MATrix LABoratory, v4.3, MathWorks Inc, USA), to perform signal pre-processing such artefacts detection, filtering, and segmentation. The EEG traces were filter with a notch filter, 50 Hz, to reject the main electricity components and then by a band-pass filter at 2-30 Hz to reject frequency components that are not related to the cognitive processed investigated. Independent components related to eye movements, blinks, and muscular artefact were removed by using the independent component analysis (ICA) (46,49). To each participant was estimated the individual alpha frequency (IAF) from the resting condition. Such bands were reported as IAF + *x*, where *x* is a number shift in the frequency domain, which is used to define the band ranges. This study was focused in theta (IAF-6, IAF-2) and alpha (IAF-2, IAF+2) activities (39,41). To summarize the overall activity over the scalp surface, global field power (GFP) was then computed. GFP is calculated by the sum of the squared values of the EEG activity at each electrode, resulting in a time-varying waveform related to the variances of the global power in the analysed EEG.

$$GFP = \frac{1}{\boldsymbol{N}_P} \sum_{i \epsilon P} x_{\alpha_i}^2 \, (t) \tag{1}$$

where x_{θ_i} describes the ith electrode in EEG activity in the cortical area of interest. In addition, P is the sets electrodes and $\boldsymbol{N}_P$ their cardinality (50).

In this study, 2 time-varying waveforms was obtained: the GFP filtered in theta (4-8 Hz) and alpha (8-13 Hz). (39) (51) To create data statistically comparable is necessary to apply the z-score transformation by using the mean and standard deviation of the GFP during the documentary baseline, according to the following formula:

$$Z_{PSA} = \frac{X_{PSA} - \mu_{Doc}}{\sigma_{Doc}}, \tag{2}$$

where Z_{PSA} is the z-score value related to the PSA, X_{PSA} is each value in the data set, and μ_{Doc} and σ_{Doc} are the mean and standard deviation of the documentary (39).

Several studies suggest FC as an area of interest to analyse approach-withdrawal (AW) and mental effort (EfI) (46,49).

3.4.1. Approach-withdrawal index (AW)

According to the EEG frontal asymmetry theory, AW index was computed as the difference between the average GFP of right and left electrodes (46). The formula defining AW is the following:

$$AW = \frac{1}{\boldsymbol{N}_P} \sum_{i \epsilon P} x_{\alpha_i}^2 \, (t) - \frac{1}{\boldsymbol{N}_Q} \sum_{i \epsilon Q} y_{\alpha_i}^2 \, (t) \tag{3}$$

$$= GFP_{\alpha_{right,frontal}} - GFP_{\alpha_{left,frontal}},$$

where $x_{\alpha_i}$and y_{α_i}represent the ith electrode in the alpha frequency that have been recorded from the right and left frontal hemispheres, respectively. In addition, P and Q are the sets of right and left electrodes and $\boldsymbol{N}_P$ and $\boldsymbol{N}_Q$ their cardinality. The $GFP_{\alpha_{right,frontal}}$ is calculated among right electrodes (Fp2, AF6, AF4, AF8) and $GFP_{\alpha_{left,frontal}}$ with the left electrodes (Fp1, AF7, AF3, F5). The time-varying alpha waveform has been estimated for each seconds of the stimuli and then averaged for all the duration of the PSA (42,47)

Positive values of AW, alpha activity lower in the left side, are associated with motivation toward the PSA. In the other hand, negative AW values, lower values of alpha activity in the right side, reflect a withdrawal and uninterested tendency (46,49).

3.4.2. Mental effort index (EfI)

The EEG signal is filtered in the theta band (Fp2, F4, F8, Fz, F7, F3, Fp1) and the GFP from such electrodes have been estimated (46,47). The formula for EfI index is:

$$EfI = \frac{1}{N_P}\sum_{i\epsilon P} x_{\theta_i}^2\,(t) \qquad (4)$$

$$= GFP_{\theta_{frontal}},$$

where x_{θ_i} describes the ith electrode in the theta frontal frequency where $\boldsymbol{N}_P$ the electrodes used. The time-varying theta waveform has been estimated for each seconds of the stimuli and then averaged for all the duration of the PSA (46).

Positive values of EfI, higher values of theta activity, correspond to a higher level of task difficulty associated with mental fatigue and a decline in cognitive performance that requires focused attention. The opposite is seen to negative or lower EfI values (45,46).

3.5. Statistical Analysis

In this study, analysis of variance (ANOVA - *repeated measures*) was performed, by using *Statistica Software* (v11, Dell Software, USA). The within-factor corresponds to PSA category with 3 levels (effective, ineffective, and awarded) and the between-factor corresponds to smoking habit with 2 levels (heavy-smokers and non-smokers). Each level of PSA category is formed by the mean of GFP z-score value for both cerebral indexes for the entire selected sample. Descriptive statistic was performed and the alpha values were established as confidence limits 0,950 and significance level 0,05. Post-hoc analysis with Duncan's multiple range test at the 5% statistical significance level was also performed for the ANOVA significant results.

4| RESULTS

The recording of the neurometric perception included the detection of the EEG signals on a sample of 38 participants aged 25-55 years old. The experimental group has been divided and analysed on the basis of the smoking habit (19 heavy-smokers and 19 no-smokers). In the following, the repeated measures ANOVA has been performed on the variables related to the mental effort (EfI) and approach-withdrawal (AW) indexes for the PSA videos. Duncan's multiple range post-hoc test was used at a $p<0.05$ level of significance.

4.1. Approach-Withdrawal Index (AW)

Descriptive statistic of the AW index value for both smoking habits participants for all categories of PSA videos are described in the following Table 4.1. The AW index values of each participant, for all categories of PSA are exposed by smoking habit in the section 4.1.1 and 4.1.2.

	Effective Video	Ineffective Video	Awarded Video
Mean	**0,08345**	**-0,03040**	**0,08412**
Standard Deviation	0,32714	0,28419	0,26688
Median	0,00287	-0,04424	0,05686
Minimum value	-0,53828	-0,67453	-0,46259
Maximum value	0,91666	0,53448	0,60588
Coefficient of variation	3,92023	9,34830	3,17256
Number of participants	38	38	38

TABLE 4.1 | Descriptive statistic of the approach-withdrawal index, for the entire sample measured for all PSAs categories.

The ANOVA effective hypothesis decomposition showed a statistically significant effect for the interaction PSA category*AW value ($F(2,72)=4,59793$, $p=0,03205$). In particular, the post-hoc analysis revealed that lower AW values were reported for ineffective video in comparison to both effective, $p=0,01088$, and awarded, $p=0,01392$ PSAs video. The interaction between effective and awarded PSAs have no significant differences ($p=0,98778$) (Table 4.2) (Figure 4.1).

Duncan Test: p-value	
Effective*Awarded	0,98778
Effective*Ineffective	0,01088*
Ineffective*Awarded	0,01392*

TABLE 4.2 | Post-hoc analysis with Duncan's test for approach-withdrawal index, of the entire sample, concerning the 3 categories of PSAs. * symbol denotes a significance at p<0.05 level.

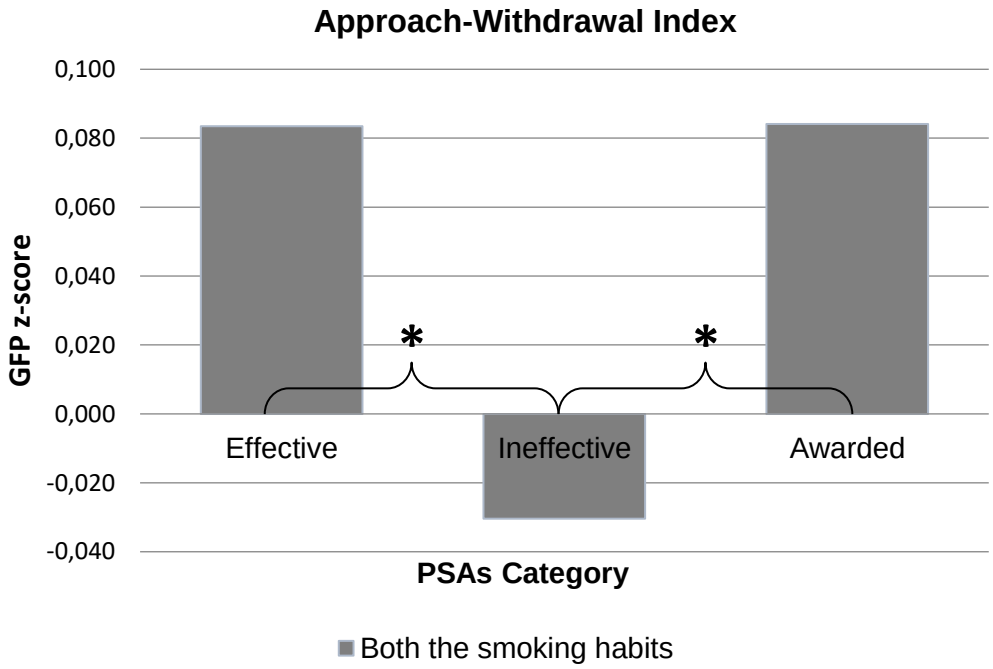

FIGURE 4.1 | Approach-withdrawal index of both smoking habits concerning the PSAs categories. * symbol denotes a significance at p<0.05 level.

The interaction PSA category*smoking habit has no statistical significance in the present index (p=0,98778).

4.1.1. Heavy-smokers

The AW values for the 19 HS participants, aged 25-55 years old, for all PSAs video category is expressed in the following table. (Table 4.3). The AW index's data from each participant for each PSAs video can be consulted in the annex V.

		GFP z-score		
		Mean Effective PSAs video	**Mean Ineffective PSAs video**	**Mean Awarded PSAs video**
HS	ALFROS	-0,30872	-0,24035	0,01572
	ALIMIC	-0,06459	-0,16940	0,00197
	AQULUI	-0,12795	-0,44802	0,15318
	ATTGIU	0,11075	-0,67453	-0,30132
	CALLAU	-0,19841	-0,08185	0,17928
	CEKANN	0,33720	-0,17927	0,32856
	CHIFAB	0,28693	-0,05672	-0,21368
	CIUROB	-0,06503	0,25385	0,23412
	COLDIE	0,21675	0,19013	0,30005
	CUOANT	0,49044	-0,52259	-0,04124
	DELCEL	-0,20545	-0,12947	-0,10958
	FEDALE	-0,17469	-0,40471	-0,03497
	FERTOM	0,21158	0,25896	0,34316
	MANANN	-0,04232	0,04295	-0,14781
	MANASS	0,02779	0,33858	0,27356
	MIEMAR	0,22213	-0,03177	-0,07066
	MORDAN	0,78258	-0,06146	0,03343
	NATAND	0,10011	0,24487	0,16000
	SILFED	0,15028	0,13006	0,05545

TABLE 4.3 | GFP z-score approach-withdrawal index for each heavy-smoker participant measured for each PSA category.

Descriptive statistic of the AW values for the sample selected is described in the following table (Table 4.4).

	Effective Video	Ineffective Video	Awarded Video
Mean	**0,09207**	**-0,08109**	**0,06101**
Standard Deviation	0,26963	0,28662	0,18835
Median	0,10011	-0,06146	0,03343
Minimum value	-0,30872	-0,67453	-0,30132
Maximum value	0,78258	0,33858	0,34316
Coefficient of variation	2,92848	3,53455	3,08706
Number of participants	19	19	19

TABLE 4.4 | Descriptive statistic of the approach-withdrawal index, for the heavy-smokers' group measured for all PSAs categories.

No statistically significant effect for the interaction PSAs category* AW index value (F(2,36)=3,14599, p=0,05506) in the HS participants was found by ANOVA test. However, ineffective PSA videos showed a lower and negative tendency than the positive and higher results for effective and awarded PSAs.

The following figure summarizes the AW results for HS sample. (Figure 4.2)

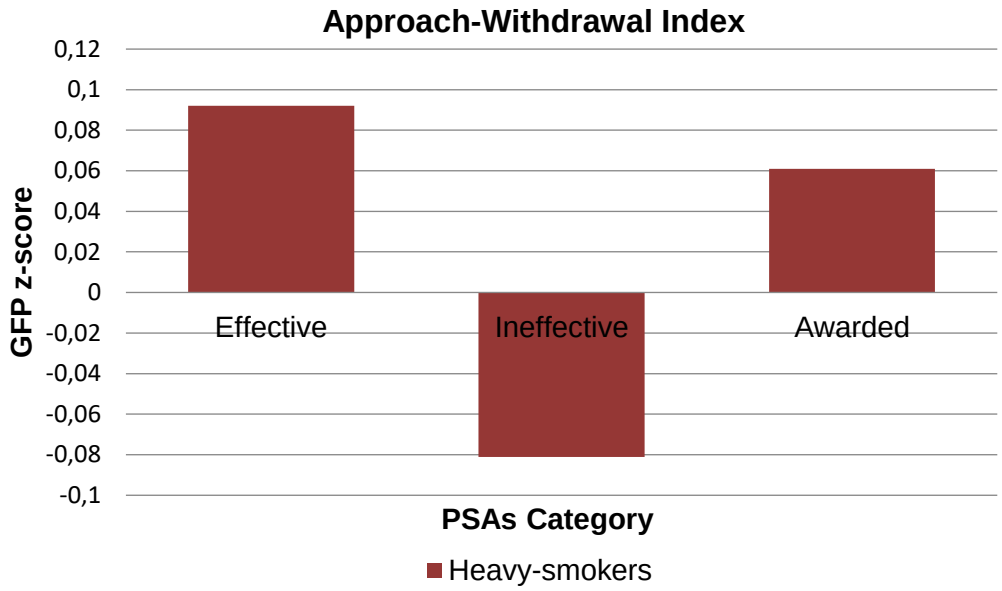

FIGURE 4.2 | Approach-withdrawal index of the heavy-smokers' group concerning the PSAs categories.

4.1.2. Non-smokers

The AW index values for the 19 NS participants, aged 25-55 years old, and all PSA categories is reported in the Table 4.5. The AW index's data from each participant for each PSAs video can be consulted in the annex V.

		GFP z-score		
		Mean Effective PSAs video	**Mean Ineffective PSAs video**	**Mean Awarded PSAs video**
NS	ALFFAB	-0,06485	-0,18338	0,12418
	AMOMIC	0,46766	0,33842	0,50341
	AUTPAO	0,45236	0,21191	0,39350
	AZZFLA	0,36612	0,38936	0,38001
	BUZJAC	-0,42928	-0,46874	-0,18332
	CAPAND	0,00714	0,09739	0,31268
	DEPNOR	-0,25248	-0,29138	-0,03824
	ESAFRA	-0,00237	-0,13202	-0,39409
	FLOCAR	-0,53822	-0,41120	-0,46259
	GORSOF	0,56665	0,53448	0,27265
	LEGSAV	-0,06651	-0,08478	0,17226
	MICCAT	-0,37937	-0,14510	-0,30962
	PASSER	0,91666	0,17850	0,60588
	PUOCRI	-0,24195	-0,24639	-0,30436
	ROSFAB	-0,09240	0,04674	-0,04709
	SALANT	0,37714	0,39003	0,49734
	SCAGAB	-0,00140	0,03771	-0,00412
	SPADAV	0,36778	0,10945	0,46067
	TRBANA	-0,03102	0,01454	0,05828

TABLE 4.5 | GFP z-score approach-withdrawal index for each non-smoker participant measured for each PSA category

Descriptive statistic of the GFP z-score for NS was performed and present in the table 4.6.

	Effective Video	Ineffective Video	Awarded Video
Mean	**0,07482**	**0,02029**	**0,10723**
Standard Deviation	0,38357	0,28007	0,33137
Median	-0,00237	0,03771	0,12418
Minimum value	-0,53822	-0,46874	-0,46259
Maximum value	0,91666	0,53448	0,60588
Coefficient of variation	5,12622	13,80219	3,09021
Number of participants	19	19	19

TABLE 4.6 | Descriptive statistic of the approach-withdrawal index, for the non-smokers' group measured for all PSAs categories.

No statistically significant effect of the PSAs category for AW index ($F(2,36)=1,11505$, $p=0,34030$) in the NS participants was found by ANOVA test. However, ineffective PSAs have lower tendency compared to effective and awarded videos. In addition, ineffective PSAs have a positive mean value.

The following figure summarizes the AW results of NS. (Figure 4.3)

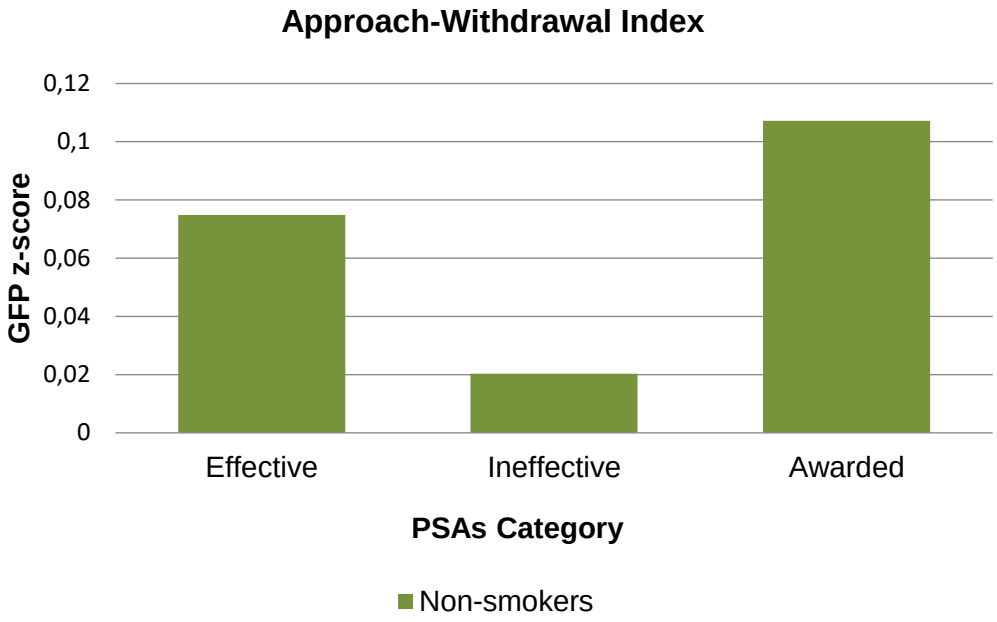

FIGURE 4.3 | Approach-withdrawal index of the non-smokers' group concerning the PSAs categories.

The Figure 4.4 shows the AW index results for HS sample, NS sample e for the entire sample (composed by HS and NS), during the observation of PSA videos. Awarded and effective PSAs have obtained a positive value of AW index, differently from the ineffective PSA. These results suggest an approach tendency measured in all sample, HS and NS, toward the Effective and Awarded PSAs, as shown in literature.

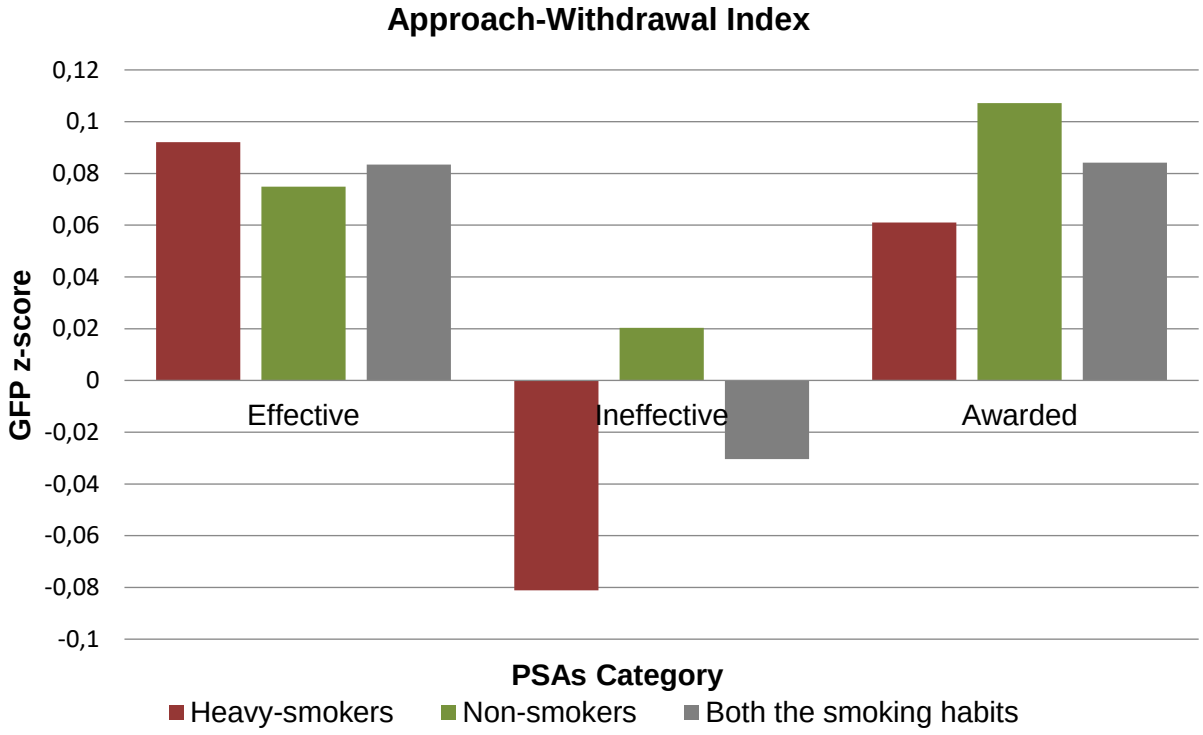

FIGURE 4.4 | Approach-withdrawal index for each PSAs category. Heavy-smokers, non-smokers and both sample.

4.2. Mental Effort Index (EfI)

Descriptive statistic of the EfI index for both smoking habits groups for all categories of PSAs are described in the following Table 4.7. The EfI index GFP z-score of each participant, for all categories of PSAs are exposed by smoking habit in section 4.2.1 and 4.2.2.

	Effective Video	Ineffective Video	Awarded Video
Mean	**-0,21398**	**0,08876**	**-0,27266**
Standard Deviation	0,32597	0,40083	0,28302
Median	-0,29791	0,05875	-0,29994
Minimum value	-0,79821	-0,64981	-0,78263
Maximum value	0,45892	1,14767	0,32418
Coefficient of variation	1,52336	4,51574	1,03797
Number of participants	38	38	38

TABLE 4.7 | Descriptive statistic of the mental effort index, for the entire sample measured for all PSAs categories.

The ANOVA effective hypothesis decomposition showed a statistically significant effect of the PSAs category (Effective, Ineffective or Awarded) for EfI index ($F(2,72)=29,68182$, $p=0,00001$). In particular, the post-hoc analysis revealed the highest and positive EfI value for ineffective video in comparison to both effective, $p=0,00012$, and awarded, $p=0,00006$ video. The interaction between effective and awarded PSAs has no significant differences ($p=0,24776$) (Table 4.8) (Figure 4.5).

Duncan Test: p-value	
Effective*Awarded	0,24776
Effective*Ineffective	0,00012*
Ineffective*Awarded	0,00006*

TABLE 4.8 | Post-hoc analysis with Duncan's test for mental effort index, of the entire sample, concerning the 3 categories of PSAs. * symbol denotes a significance at $p < 0.05$ level.

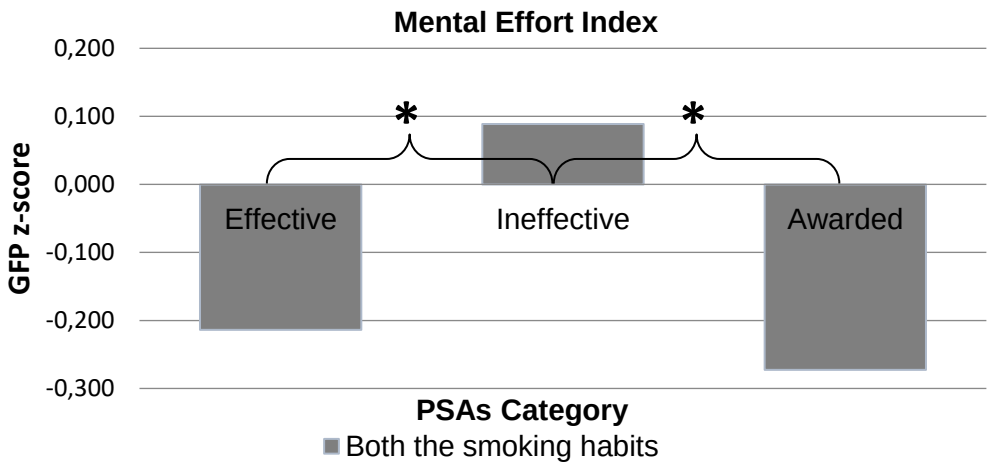

FIGURE 4.5 | Mental effort index of both smoking habits concerning the PSAs categories. * symbol denotes a significance at p<0.05 level.

The interaction PSA category*smoking habit has no statistical significance in the present index (p=0,90235).

4.2.1. Heavy-smokers

The AW index values for 19 HS participants, aged 25-55 years old measured for each PSAs video categories is reported in the following table. (Table 4.9). The EfI index's data from each participant for each PSAs video can be consulted in the annex V.

		GFP z-score		
		Mean Effective PSAs video	**Mean Ineffective PSAs video**	**Mean Awarded PSAs video**
HS	ALFROS	-0,43943	-0,11235	-0,50640
	ALIMIC	-0,42258	0,06074	-0,34591
	AQULUI	-0,14630	1,14767	-0,21047
	ATTGIU	0,14590	0,70097	0,12335
	CALLAU	-0,46307	0,11842	-0,41078
	CEKANN	-0,31691	-0,35863	-0,23277
	CHIFAB	-0,53923	-0,39547	-0,65823
	CIUROB	0,17258	-0,36068	-0,19662
	COLDIE	-0,48474	0,41507	-0,52566
	CUOANT	-0,43774	-0,19980	-0,62815
	DELCEL	-0,32289	0,24405	0,08326
	FEDALE	-0,02369	-0,24459	-0,27999
	FERTOM	-0,34176	-0,04276	-0,05041
	MANANN	-0,23384	-0,03470	-0,28593
	MANASS	0,05153	-0,31406	-0,29583
	MIEMAR	-0,47375	0,26014	0,04556
	MORDAN	0,39377	0,01636	-0,56864
	NATAND	0,20224	0,53938	-0,37843
	SILFED	-0,42673	0,23462	-0,26008

TABLE 4.9 | GFP z-score mental effort index for each heavy-smoker participant measured for each PSA category.

Descriptive statistic results for the Efi index are described in the following table (Table 4.10).

	Effective Video	Ineffective Video	Awarded Video
Mean	**-0,21183**	**0,08940**	**-0,25153**
Standard Deviation	0,36977	0,40764	0,33266
Median	-0,26720	0,06500	-0,31203
Minimum value	-0,79821	-0,64981	-0,78263
Maximum value	0,45892	0,74562	0,32418
Coefficient of variation	1,74563	4,55970	1,32255
Number of participants	19	19	19

TABLE 4.10 | Descriptive statistic of the mental effort index, for the heavy-smokers' group measured for all PSAs categories.

The ANOVA effective hypothesis decomposition showed a statistically significant effect for the PSAs category ($F(2,36)= 9,50926$, $p=0,00048$) in the sample composed by HS.

The post-hoc analysis revealed the ineffective PSAs have significantly higher EfI index values than effective ($p=0,00239$) and awarded ($p=0,00004$). The interaction between effective and awarded PSAs have no significant differences ($p=0,40722$) (Table 4.11).

Duncan Test: P-value	
Effective*Awarded	0,40722
Effective*Ineffective	0,00239*
Ineffective*Awarded	0,00004*

TABLE 4.11 | Post-hoc analysis with Duncan's test for mental effort index, of heavy-smokers' group, concerning the 3 categories of PSAs. * symbol denotes a significance at $p<0.05$ level.

The following figure summarizes the EfI results of HS. (Figure 4.6)

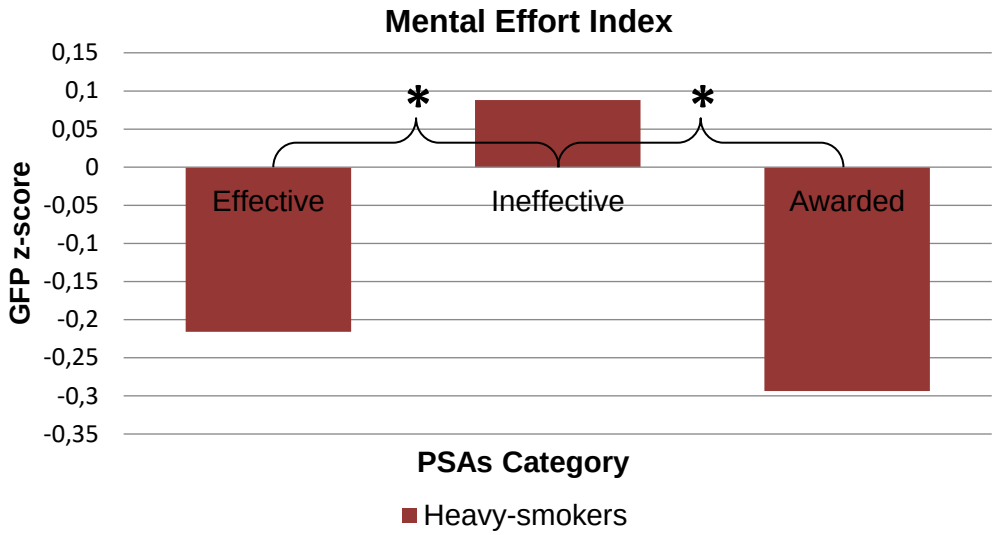

FIGURE 4.6 | Mental effort index of the heavy-smokers' group concerning the PSAs categories. *statistically significant differences.

4.2.2. Non-smokers

The following table describes the EfI index of 19 NS participants, aged 25-55 years old, for all PSAs video category (Table 4.12). The EfI index's data from each participant for each PSAs video can be consulted in the annex V.

		GFP z-score		
		Mean Effective PSAs video	**Mean Ineffective PSAs video**	**Mean Awarded PSAs video**
NS	ALFFAB	-0,37930	0,06500	-0,35809
	AMOMIC	-0,67014	-0,55153	-0,67453
	AUTPAO	-0,34205	0,07165	-0,30406
	AZZFLA	0,19037	0,73176	0,07300
	BUZJAC	-0,07341	0,04448	-0,20132
	CAPAND	-0,18793	0,24614	-0,22820
	DEPNOR	0,45892	0,55933	0,11369
	ESAFRA	0,09107	0,19459	0,12391
	FLOCAR	-0,63600	-0,17280	-0,45867
	GORSOF	-0,79821	-0,64981	-0,78263
	LEGSAV	-0,12088	-0,13254	-0,31203
	MICCAT	-0,02018	0,35510	0,05537
	PASSER	-0,47293	-0,37319	-0,61175
	PUOCRI	-0,46278	0,05675	-0,54168
	ROSFAB	-0,27891	0,03290	-0,33214
	SALANT	-0,68145	-0,41110	-0,52545
	SCAGAB	0,35663	0,55170	0,31799
	SPADAV	0,26965	0,74562	0,32418
	TRBANA	-0,26720	0,33456	-0,45667

TABLE 4.12 | GFP z-score mental effort index for each non-smoker participant measured for each PSA category.

The following table represents those statistical descriptive values (Table 4.13).

	Effective Video	Ineffective Video	Awarded Video
Mean	**-0,21614**	**0,08813**	**-0,29380**
Standard Deviation	0,28579	0,40508	0,23031
Median	-0,32289	0,01636	-0,28593
Minimum value	-0,53923	-0,39547	-0,65823
Maximum value	0,39377	1,14767	0,12335
Coefficient of variation	1,32228	4,59658	0,78390
Number of participants	19	19	19

TABLE 4.13 | Descriptive statistic of the mental effort index, for the non-smokers' group measured for all PSAs categories.

The ANOVA showed a statistically significant effect for the interaction PSAs category* EfI index value in the NS participants.

Duncan's test showed that EfI values for ineffective PSAs are significantly higher than effective (p=0,00012) and awarded (p=0,00006) PSAs. The interaction effective*awarded has no statistically significant (p=0,32319) (Table 4.14).

Duncan Test: P-value	
Effective*Awarded	0,32319
Effective*Ineffective	0,00012*
Ineffective*Awarded	0,00006*

TABLE 4.14 | Post-hoc analysis with Duncan's test for mental effort index, of non-smokers' group, concerning the 3 categories of PSAs. *statistically significant differences. * symbol denotes a significance at p<0.05 level

The following figure summarizes the EfI results of NS participants (Figure 4.7).

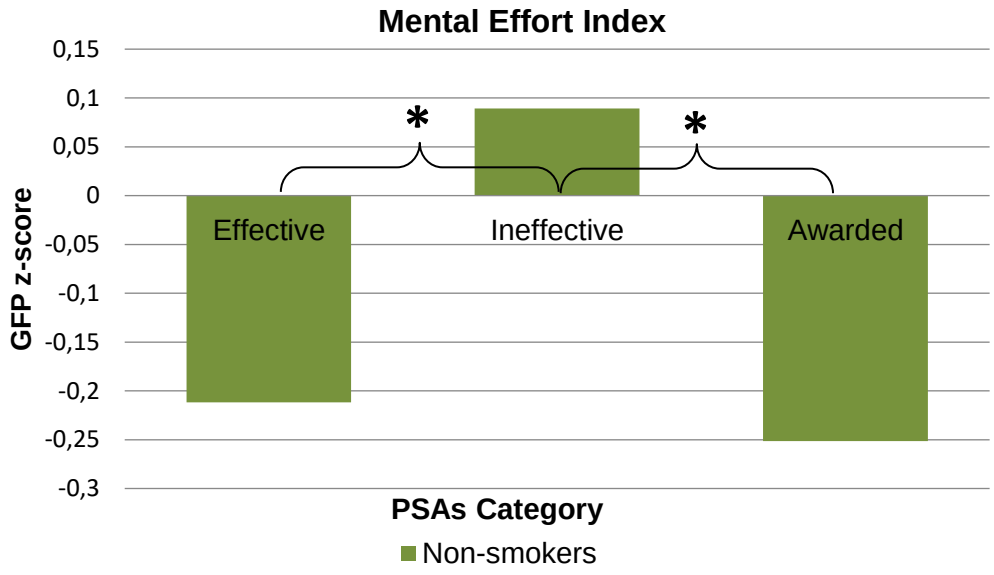

FIGURE 4.7 | Mental effort index of the non-smokers' group concerning the PSAs categories. * symbol denotes a significance at p<0.05 level

In summary, the results obtained for EfI index are similar to those expected. In fact, theta values are increased in ineffective PSAs due to the higher difficulty to understand the message from the selected sample. Effective and awarded PSAs both presented similar results of the index (negative values). The EfI index for each PSAs category and smoking habit is reported in the Figure 4.8.

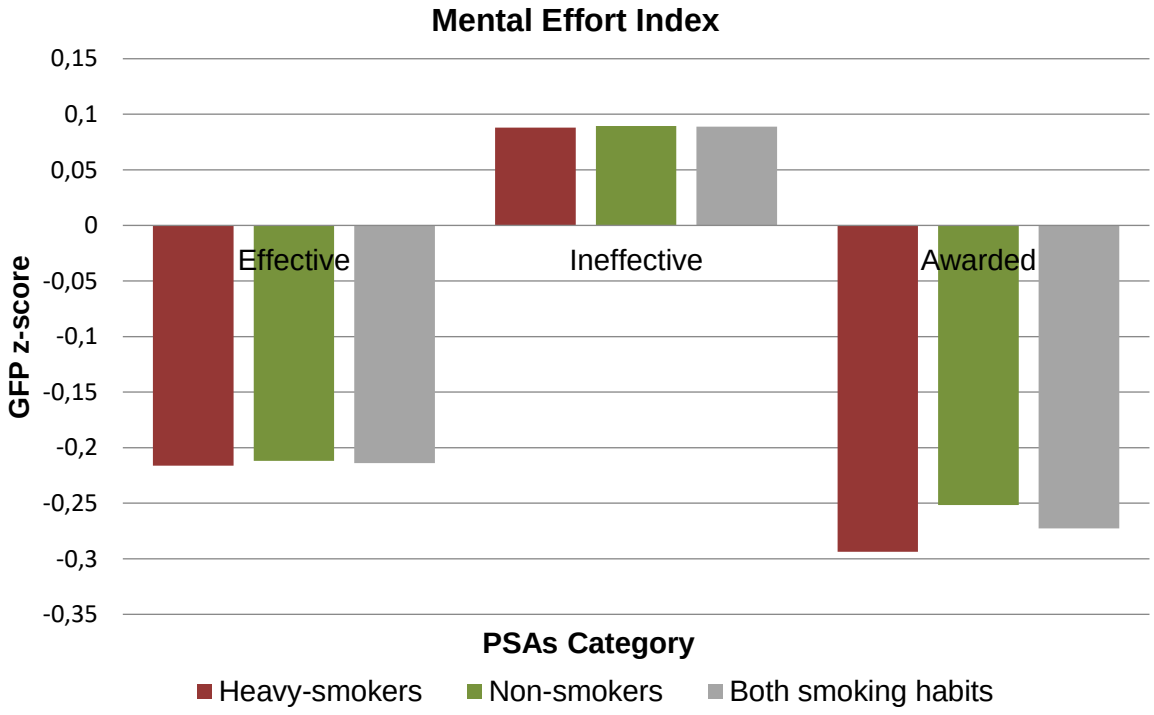

FIGURE 4.8 | Mental effort index for each PSAs category. Heavy-smokers and non-smokers.

Table 4.15 is a summary of all the results for both indexes relating all the variables.

Index	Sample	Variable	p-value
AW	All sample	Smoking habit	Without statistical significance
		PSA category	0,01321*
		Smoking habit*PSA category	Without statistical significance
	HS	PSA category	Without statistical significance
	NS	PSA category	Without statistical significance
Efl	All sample	Smoking habit	Without statistical significance
		PSA category	0,00001*
		Smoking habit*PSA category	Without statistical significance
	HS	PSA category	0,00048*
	NS	PSA category	0,00001*

TABLE 4.15 | Summary of the p-value for both indexes relating all the variables. * symbol denotes a significance at $p<0.05$ level

5| DISCUSSION

5.1. Electroencephalographic Indexes to Evaluate the Effectiveness of Public Service Announcements

The two indexes designed in this study were applied to all PSAs category and evaluated considering the smoking habit. The ANOVA effective hypothesis decomposition test showed that smoking habit, the participant being a heavy-smoker or non-smoker, does not have a statistically significant effect in both indexes. The absence of difference between heavy-smokers and non-smokers in reaction to anti-tobacco stimuli supports the most recent studies indicating that non-smokers are more favourable in rating anti-tobacco PSAs; however, the mechanisms of behaviour change are the same for smokers and non-smokers (33).

The statistical analysis revealed that the variable category for PSAs, with three levels (effective, awarded and ineffective), when considering the whole sample, has a statistically significant effect on the value of each index, as reported in the literature due to the different types of communication *i.e.* theme message, production style and emotional content (26).

Concerning the AW index results for the whole sample, effective and awarded PSAs show significant relative higher activity in the left frontal hemisphere and a reduced activity in right frontal hemisphere, which is associated with alpha band desynchronization (low alpha activity) and synchronization (higher alpha activity) in the left and right frontal areas, respectively. In contrast, ineffective PSA had negative AW values. It means the right frontal hemisphere was activated relatively to the left frontal hemisphere as a consequence of alpha band desynchronization in the right side and synchronization in the left side. Based on these results, it can be concluded a favourable interest and approach of all subjects in the effective and awarded compared to ineffective marketing stimuli (46,49). Confronting these outcomes with HERA model, awarded and effective PSAs will be better encoded from short memory to long memory due to the left PFC activation. In turn, the activation of the right PFC as consequence of the observation of ineffective PSAs play a role in retrieval the encoding phase of information. (35). In addition, no statistically significant difference between awarded and effective PSAs was found. This may indicate the types of communication used are similar and thus produce similar effects on the participants.

Confronting the AW index results with the types of communication of anti-tobacco MMCs several points can be discussed and focus of future research. As suggested by the literature, marketing stimuli that arouse high levels of negative emotion have been associated with an increased number of quit attempts in adult population (46). The present study supports the

above evidence; all the awarded and effective PSAs arouse negative feelings about smoking and have a persuasive impact in both heavy-smokers and non-smokers. This may be associated with the fear elicited by the campaigns about death or the negative consequences of tobacco use, not only to the smoker but also to those around him.

On the other hand, arousing positive feelings about quitting (*Feel free to say no*) does not stimulate heavy-smokers or create interest in the campaign. Through an analysis of AW results and the categorization of PSAs it can be found that emotional content by itself does not predict the effectiveness of a campaign; it is possible to conclude this since two ineffective PSAs (*Think. Don't smoke* and *Tobacco is wacko)* elicit negative feelings about smoking but nevertheless do not arouse the interest of heavy-smokers. Without neglecting the emotional content, it should be highlighted the contribution of the theme message and style of production for estimate the effectiveness of an anti-tobacco campaign.

Concerning the lowest AW value for the ineffective PSAs in the total sample, the social norms (*Feel free to say no; Think. Don't smoke* and *Tobacco is wacko*) and positive consequences of smoking cessation (*Feel free to say no*) seem to be message themes that suggest the withdrawal tendency. These results agree with the propose that social norms messages are effective only for young people due to their concern about the perception of others about themselves (30). In this study, the age of our participants varies between 25 and 55 years old; it was expected PSAs using social norms as a theme message would not be effective. However, more studies must be done since *Help.EU* PSA was considered an effective anti-smoking PSA despite presenting social norms as message theme. The PSA with the message of positive consequences for smoking cessation seems to be ineffective in the adult sample, as observed in the present study; one possible reason is the image component associated with this theme message may not provoke high levels of emotional content (26). On the other hand, PSAs coded with SHS/ paternalist content (*Smoking kid, Baby love* and *Breath holder)* and negative health effects (*Bubble wrap, CDC Roosevelt* and *Fatty cigarettes)* are seen as the most interesting and approaching stimuli to the general sample; all the awarded PSAs have negative health effect (*Fatty cigarettes*) or exposure to SHS/Paternalistic (*Baby love* and *Breath holder*) as a message theme.

An analysis of the style of production reveals that the presence of children (*Smoking kid*, *Breath holder* and *Baby love*) and a strong image component (*Bubble wrap* and *Fatty cigarettes*) in the campaigns increase the approach toward this PSA style; in this study this can be observed for both effective and awarded PSAs. In this study, the testimonial style produced with strangers who arouse negative feelings about smoking (*Breath holder*) appear interesting for the heavy-smokers group, non-smokers and the general sample. Additionally, the PSA in which the protagonists are celebrities with the aim to elicit positive feelings to stop smoking

(*Feel free to say no)* were categorized as ineffective and considered unappealing by the general sample of the study. A possible reason for these outcomes is the connection that participants may have had with the unknown subjects that aroused strong negative feelings but not with the celebrities. The effectiveness of PSAs with an ironic/humour style of production is not well established in literature (31). The results of the present study are also inconclusive, since campaigns coding the same way report opposite AW results (*Help.EU* and *Think. Don't smoke)*. The awarded *Breath holder* campaign has a strong ironic component noticed by the child's attitudes towards the tobacco use; the ironic production style may have been used to catch the smoker's attention and increase the guilty feeling for causing discomfort and sadness to a child in the final scene. Facing the contradictory results for testimonials and ironic/humour PSAs, more research on the message theme and emotional content of these production styles is recommended.

Concerning heavy-smoker's results for AW, no statistically significant effect was found for the variable PSA category. However, the tendency presented is supported by the literature and is similar to the general sample.

Regarding the AW index results of non-smokers, no statistically significant effect was found between the 3 PSAs categories. Nevertheless, a higher and positive tendency is present for awarded and effective PSAs. Differently to the results obtained for heavy-smokers and for the general sample, non-smokers reported a positive approach tendency for ineffective PSAs (although less than effective and awarded PSAs). This pattern of findings might indicate that non-smokers have an approach motivation toward the 3 categories of PSAs and find attractive all the types of communication. Following the HERA model's line of reasoning, the 3 PSAs category activate the left PFC (by the increased alpha frequency desynchronization), it represents better encoding information from short memory to long memory (35). However, additional research with statistical significance must be supported to understand how anti-tobacco MMCs that aim to prevent tobacco use among non-smokers should be structured and which types of communication should be used.

The different PSAs categories play a relevant role in mental effort expended by the participants when the observation of PSAs. As mentioned previously, the PSA category*smoking habit interaction for EfI index does not have a statistically significant result, which means HS and NS participants have the same tendency. For both smoking habits, ineffective PSAs have the highest EfI index value comparatively to effective and awarded PSAs. Concerning these results, it is proposed higher values of EfI index are due to an unwillingness of alert and increased mental fatigue during the observation of ineffective PSAs. This state of decreasing vigilance is counterbalanced by employing more cognitive resources in the task (43); in the EEG spectra of the current study is perceptible an increase of theta activity in the frontal areas

when the observation of Ineffective PSAs as a response to the recruitment of extra-cognitive resources. The opposite occurs for effective and awarded PSAs, the participants' EEG spectra have relatively lower values of theta activity and consequently lower and negatives EfI index results. Similar to the results found in the AW index, no statistically significant difference between effective and awarded PSAs was found. The EfI index results obtained show how the perception of PSAs is different based on different type of stimuli proposed. The participants during the observation of the ineffective PSAs seem to have difficulty in perceiving the message that is intended to be communicated. This difficulty generates in the participant fatigue and progressive withdrawal of attention. More studies need to be performed in order to perceive the types of communication of PSAs that clearly communicate the proposed message.

After an analysis of the EEG indexes, it can be concluded that the present neuroelectric-based indexes represent an objective method that evaluates both the interest (AW index) and the mental effort (EfI index) that an anti-smoking marketing stimulus evokes in HS and NS groups. The present methodology does not evaluate the specific types of communication used in PSAs, however, is possible to perceive the message theme, style of production and the valence of the emotional content that arouses greater interest and is more effortlessly perceived by the participant.

In conclusion, AW and EfI indexes are consistent with the classification of effectiveness based on behavioral and economic KPIs proposed by Coffman and Varcoe (47,48), thus they may be an useful tool to predict the effectiveness of anti-tobacco Public Service Annoucements.

5.2. Critical Steps and Future Investigation

The objective of the study originally was focused to evaluate the effectiveness of anti-tobacco MMCs in video and image through EEG indexes. However, the results of PSAs images for the AW and EfI indexes in both smokers and non-smokers groups were inconclusive because of the lack of statistical power and significance. One possible reason for this finding is the increasing impact of digital technologies on society. The interactive use of technologies in MMCs has the advantage of capture and engage the target more quickly and unconsciously compared to the marketing strategies considered static, such as images (52). Nevertheless, further studies on the effectiveness of anti-smoking images should be applied. It was then decided that more detailed and critical analysis of the results obtained for video PSAs should be reinforced in the current study.

Concerning the PSAs selection, an effort should have been done for not select PSAs with more than 5 years of difference. This fact gains its relevance due to the difference in quality and production techniques of videos with 15 years compared to those of nowadays. In this sense,

the participant feels compelled not only by the message, style of production and emotional content of the PSAs that is communicated but by the poor quality of production. Another point to be noted is the that type of communication was appropriate to the target and culture of the year of production, so what may be considered ineffective at the present time could have been or not an effective anti-tobacco campaign.

The EEG recording methodology described in the current study has a few limitations that need to be considered and object of future research. The ICA procedure to remove ocular and movement artefacts is sensitive to the number of EEG scalp electrodes employed. In this project were used 10 electrodes, due to the lower number of EEG sensors, the number of different kinds of artefacts able to be removed also decreased. Another limitation of this technique is the total duration of time recommended, maximum of 1 hour for each participant to avoid possible bias because of the tiredness and exhaustion which can be induced during the recording (50).

This work supports previous findings regarding the application of EEG neurometric indexes to determine previously the success of an anti-tobacco MMCs (42,46). However, the present results need further investigation with enlarged stimuli sample and number of participants. Although, in this project, the selection of participants is restricted to the ages 25-55, future research about specific participants features such as socio-economic status and gender should be done. Would also be interesting to work more in-deep the types of communication of MMCs. The eye tracking technology can help to identify regions of interest and attention patterns during the observation of anti-tobacco MMCs. This technology can provide an exceptional view on participants' moment-to-moment processing of the visual marketing stimuli, giving information about the MMCs features of communication such as colours, edges, luminance, shapes in a scene that are receiving more attention (53).

6| CONCLUSION

The tobacco epidemic is considered one of the biggest concerns of this century by the WHO. Despite the progress in controlling tobacco epidemic by MPOWER policy program, governments must focus and optimize monetary funds on effective anti-tobacco strategies. Anti-tobacco mass media campaigns have a potential impact in promoting information about the dangers of tobacco use and exposure to second-hand smoke. However, existing methods for evaluating the effectiveness of a campaign are usually based on subjective, non-quantitative data, through written and verbal questionnaires which are dependent on the conscious perceptions and willingness of the participants to answer. This lack of accuracy in data collection, that allows prior assessment of a campaign, has led researchers and marketing community to analyze the neurophysiologic signal variations to obtain insights into the emotional and cognitive reactions of the participants in response to anti-tobacco mass media campaigns.

In the current work, the results highlight an involvement of the frontal and pre-frontal region during the observation of the PSAs. In agreement with the approach-withdrawal theory, the PSAs more interesting and pleasant for the participants activate the left frontal lobe showing a desynchronization of the EEG alpha activity. On the other hand, it was confirmed an increasing of EEG theta activity in the frontal lobe associated with the recruitment of cognitive resources to combat the decline of attention induced by mental fatigue during the observation of boring and confusing PSAs. With the application of EEG indexes some conclusions about the different types of communication of anti-tobacco mass media campaigns could be drawn. Anti-tobacco campaigns, whether designed for smokers or non-smokers, attract more interest when they arouse negative feelings about smoking or second-hand smoke in the target population. The theme messages that successfully produce this effect use paternalistic issues and the negative effects of smoking. Strong image components, and personal and emotional testimonials are the most effective style of production to communicate the anti-smoking message.

This study contributes to the validation of EEG neurometric indexes in the evaluation of effective and ineffective anti-tobacco PSAs. However, further studies with larger groups of population are necessary to validate this methodology, in order to predict the population cognitive and emotional perception of the features of an anti-tobacco campaign. This methodology allows governments to develop effective and sustainable anti-tobacco mass media campaigns with a favourable cost-benefit ratio.

Overall, these conclusions are consistent with the already existing literature. Integration of high quality different methods as neurophysiological tools may in the future show their potential utility in this field.

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8| ANNEXES

Annex I

Smoking habit, age and gender of the study's participants

Smoking Habit	Participants	Age	Gender
HS	ALFROS	51	Feminine
	ALIMIC	34	Masculine
	AQULUI	25	Masculine
	ATTGIU	54	Masculine
	CALLAU	25	Feminine
	CEKANN	55	Masculine
	CHIFAB	47	Feminine
	CIUROB	50	Feminine
	COLDIE	28	Feminine
	CUOANT	35	Masculine
	DELCEL	31	Masculine
	FEDALE	42	Feminine
	FERTOM	35	Masculine
	MANANN	30	Masculine
	MANASS	28	Feminine
	MIEMAR	39	Masculine
	MORDAN	38	Feminine
	NATAND	44	Masculine
	SILFED	27	Masculine
NS	ALFFAB	39	Masculine
	AMOMIC	45	Masculine
	AUTPAO	29	Feminine
	AZZFLA	29	Masculine
	BUZJAC	55	Masculine
	CAPAND	31	Feminine
	DEPNOR	26	Feminine
	ESAFRA	34	Masculine
	FLOCAR	55	Feminine
	GORSOF	36	Masculine
	LEGSAV	25	Masculine
	MICCAT	28	Masculine
	PASSER	29	Feminine
	PUOCRI	51	Feminine
	ROSFAB	34	Masculine
	SALANT	45	Feminine
	SCAGAB	46	Masculine
	SPADAV	25	Masculine
	TRBANA	28	Feminine

TABLE I.1 | Smoking habit, age and gender of the study's participants

Annex II

Public Service Announcements: Images

- **Effective images**

FIGURE II.1 | PSAs effective image 1.

FIGURE II.2 | PSAs effective image 2.

FIGURE II.3 | PSAs effective image 3.

FIGURE II.4 | PSAs effective image 4.

- **Ineffective images**

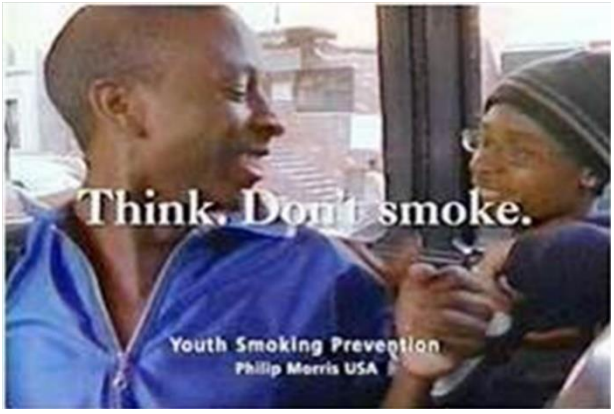

FIGURE II.5 | PSAs ineffective image 1.

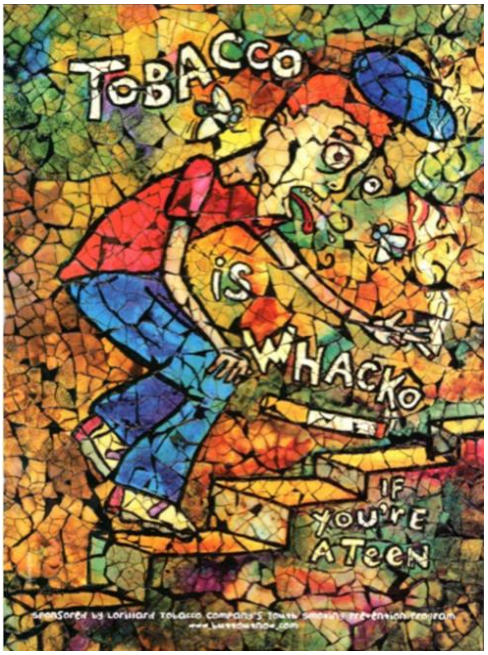

FIGURE II.6 | PSAs ineffective image 2.

FIGURE II.7 | PSAs ineffective image 3.

- **Awarded images**

FIGURE II.8 | PSAs awarded image 1.

FIGURE II.9 | PSAs awarded image 2.

FIGURE II.10 | PSAs awarded image 3.

Annex III

Frames of Public Service Announcements: Videos

- **Effective videos**

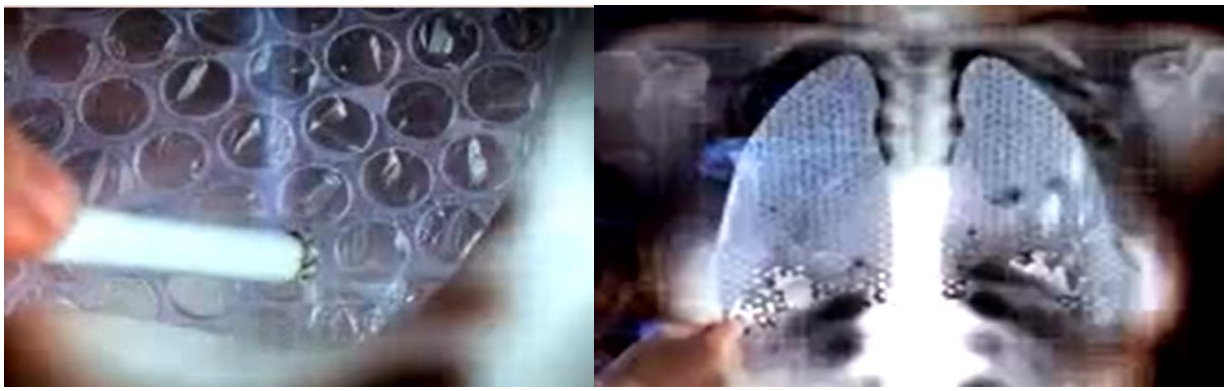

FIGURE III.1 | *Bubble wrap.*

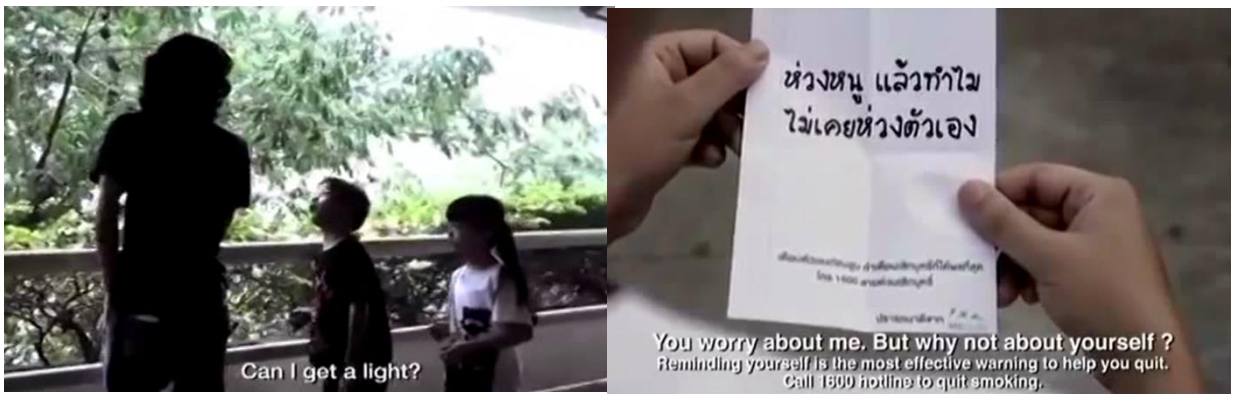

FIGURE III.2 | *Smoking Kid.*

FIGURE III.3 | *Help.EU.*

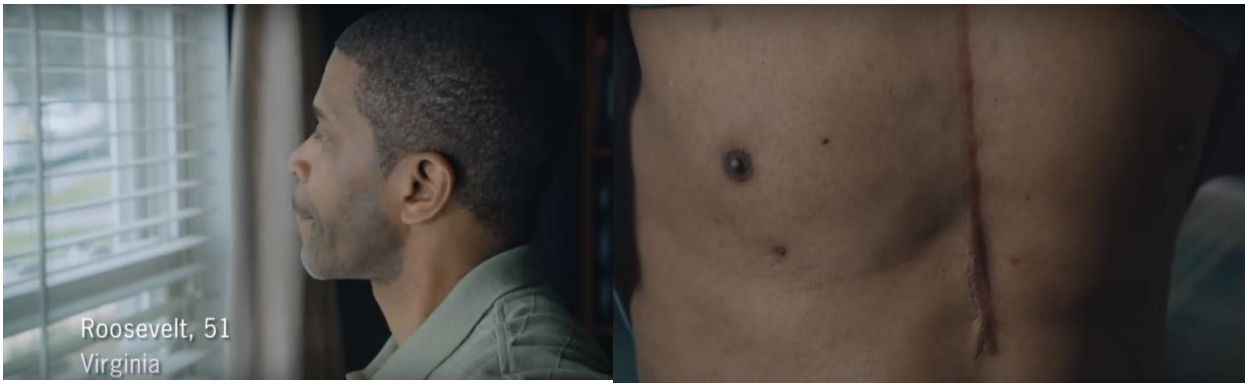

FIGURE III.4 | *CDC Roosevelt.*

- **Ineffective videos**

FIGURE III.5 | *Feel free to say no.*

FIGURE III.6 | *Think. Don't smoke.*

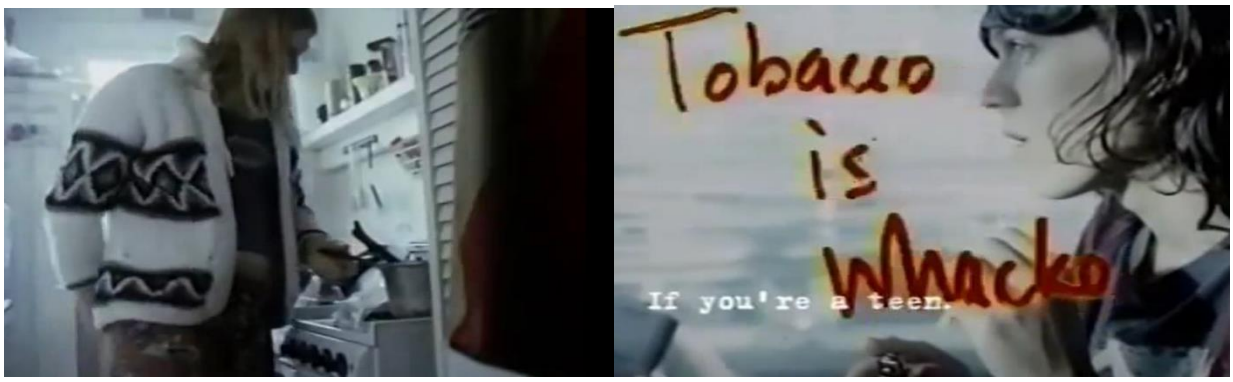

FIGURE III.7 | *Tobacco is wacko.*

- **Awarded videos**

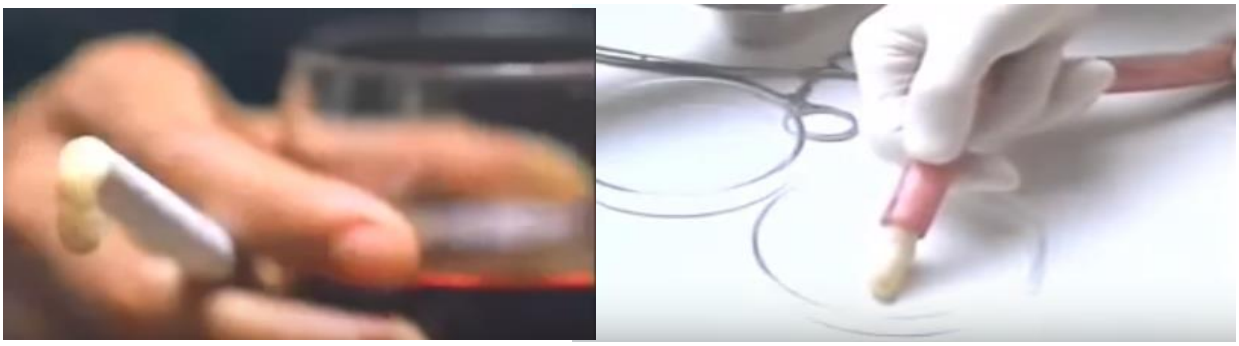

FIGURE III.8 | *Fatty cigarettes.*

FIGURE III.9 | *Baby love.*

FIGURE III.10 | *Breath holder.*

Annex IV

Baseline collected from IAPS database

- **Images**

FIGURE IV.1 | Baseline image 1.

FIGURE IV.2 | Baseline image 2.

FIGURE IV.3 | Baseline image 3.

FIGURE IV.4 | Baseline image 4.

FIGURE IV.5 | Baseline image 5.

FIGURE IV.6 | Baseline image 6.

- **Video**

FIGURE IV.7 | Frame of the baseline video: documentary about the space.

Annex V

Data from each participant for each PSAs

- **Approach-Withdrawal (AW) index**

		GFP z-score Effective PSAs				
		Bubble wrap	***Smoking kid***	***Help.eu***	***CDC Roosevelt***	**MEAN**
HS	ALFROS	-0,41932	-0,20121	-0,28313	-0,33121	-0,30872
	ALIMIC	-0,31041	-0,31234	-0,13770	0,50208	-0,06459
	AQULUI	0,18584	-0,01188	-0,19554	-0,49021	-0,12795
	ATTGIU	-0,12724	0,34169	-0,25168	0,48025	0,11075
	CALLAU	-0,27772	-0,14242	-0,17197	-0,20155	-0,19841
	CEKANN	-0,07178	-0,08107	0,19465	1,30700	0,33720
	CHIFAB	0,32963	0,22782	0,31343	0,27685	0,28693
	CIUROB	-0,16662	-0,04118	-0,04512	-0,00720	-0,06503
	COLDIE	0,32077	-0,41698	0,40761	0,55559	0,21675
	CUOANT	0,49033	0,42351	0,42073	0,62717	0,49044
	DELCEL	-0,05544	-0,13409	-0,37620	-0,25607	-0,20545
	FEDALE	-0,22904	-0,09187	-0,09526	-0,28258	-0,17469
	FERTOM	0,37640	0,09339	0,04258	0,33394	0,21158
	MANANN	0,08279	-0,03840	-0,18033	-0,03334	-0,04232
	MANASS	0,13893	0,10474	-0,31544	0,18295	0,02779
	MIEMAR	0,04825	0,52831	0,01599	0,29595	0,22213
	MORDAN	-0,67915	4,51442	-0,54961	-0,15535	0,78258
	NATAND	0,27184	0,28382	-0,16533	0,01011	0,10011
	SILFED	0,23781	0,20063	0,09714	0,06553	0,15028
NS	ALFFAB	0,05802	0,19210	-0,22091	-0,28861	-0,06485
	AMOMIC	0,46051	0,52951	0,54536	0,33528	0,46766
	AUTPAO	0,51646	0,22822	0,43056	0,63420	0,45236
	AZZFLA	0,06732	0,25630	0,42234	0,71851	0,36612
	BUZJAC	-0,66037	-0,43995	-0,09062	-0,52616	-0,42928
	CAPAND	0,21305	-0,28095	0,08771	0,00874	0,00714
	DEPNOR	-0,12483	-0,25908	-0,60165	-0,02435	-0,25248
	ESAFRA	0,05612	-0,35376	0,11843	0,16975	-0,00237
	FLOCAR	-0,67513	-0,55599	-0,39898	-0,52277	-0,53822
	GORSOF	1,13618	0,42778	0,46985	0,23280	0,56665
	LEGSAV	-0,59517	0,32355	-0,04677	0,05233	-0,06651
	MICCAT	-0,42058	-0,20883	-0,66809	-0,21998	-0,37937
	PASSER	1,05239	0,89611	0,86501	0,85314	0,91666
	PUOCRI	-0,56914	-0,53878	0,36409	-0,22398	-0,24195
	ROSFAB	-0,30062	0,17370	-0,19235	-0,05033	-0,09240
	SALANT	0,37786	0,25755	0,46944	0,40370	0,37714
	SCAGAB	0,40348	-0,11616	-0,33314	0,04023	-0,00140
	SPADAV	0,12200	0,45652	0,63374	0,25886	0,36778
	TRBANA	0,04590	-0,08024	-0,37134	0,28159	-0,03102

TABLE V.1 | GFP z-score of approach-withdrawal index, of each participant, for each effective PSA.

		GFP z-score Ineffective PSAs			
		Feel free	***Think don't***	***Tobacco***	**MEAN**
HS	ALFROS	-0,48625	-0,35086	0,11606	-0,24035
	ALIMIC	-0,30005	-0,28946	0,08132	-0,16940
	AQULUI	-0,37440	0,36654	-1,33619	-0,44802
	ATTGIU	-1,58596	-0,14751	-0,29013	-0,67453
	CALLAU	-0,04580	-0,01614	-0,18361	-0,08185
	CEKANN	-0,15258	-0,51050	0,12528	-0,17927
	CHIFAB	-0,03681	0,16009	-0,29343	-0,05672
	CIUROB	0,36049	0,27031	0,13074	0,25385
	COLDIE	0,93013	-0,40441	0,04467	0,19013
	CUOANT	-0,86942	-0,37096	-0,32740	-0,52259
	DELCEL	0,23250	-0,41629	-0,20461	-0,12947
	FEDALE	-0,33767	-0,54923	-0,32722	-0,40471
	FERTOM	0,51329	0,14262	0,12098	0,25896
	MANANN	0,17651	0,20147	-0,24914	0,04295
	MANASS	0,72702	0,29587	-0,00714	0,33858
	MIEMAR	0,00077	0,07925	-0,17533	-0,03177
	MORDAN	-0,18605	0,38401	-0,38234	-0,06146
	NATAND	0,13716	0,80434	-0,20691	0,24487
	SILFED	0,23946	0,02924	0,12147	0,13006
NS	ALFFAB	-0,33147	-0,14101	-0,07765	-0,18338
	AMOMIC	0,05376	0,38673	0,57476	0,33842
	AUTPAO	-0,01406	-0,00967	0,65945	0,21191
	AZZFLA	0,12580	0,72179	0,32048	0,38936
	BUZJAC	-0,60970	-0,13427	-0,66224	-0,46874
	CAPAND	-0,47752	0,25721	0,51247	0,09739
	DEPNOR	-0,35117	-0,07918	-0,44380	-0,29138
	ESAFRA	0,26889	-0,61090	-0,05404	-0,13202
	FLOCAR	-0,15745	-0,45453	-0,62162	-0,41120
	GORSOF	0,53580	0,32586	0,74179	0,53448
	LEGSAV	-0,19808	-0,17747	0,12120	-0,08478
	MICCAT	0,27621	-0,34221	-0,36930	-0,14510
	PASSER	0,19559	0,47812	-0,13820	0,17850
	PUOCRI	-0,43452	0,27611	-0,58076	-0,24639
	ROSFAB	0,07881	-0,02499	0,08639	0,04674
	SALANT	-0,07708	0,43647	0,81069	0,39003
	SCAGAB	0,01824	0,10170	-0,00681	0,03771
	SPADAV	0,07676	-0,09669	0,34829	0,10945
	TRBANA	-0,51795	0,44670	0,11487	0,01454

TABLE V.2 | GFP z-score of approach-withdrawal index, of each participant, for each ineffective PSA.

		GFP z-score Awarded PSAs			
		Fatty cigarettes	***Baby love***	***Breath holder***	**MEAN**
HS	ALFROS	0,21035	-0,37539	0,21219	0,01572
	ALIMIC	-0,25497	0,25460	0,00629	0,00197
	AQULUI	0,26510	0,13309	0,06136	0,15318
	ATTGIU	-0,15763	-0,29832	-0,44802	-0,30132
	CALLAU	0,30490	0,29445	-0,06151	0,17928
	CEKANN	0,38114	0,30060	0,30393	0,32856
	CHIFAB	-0,07203	-0,09074	-0,47826	-0,21368
	CIUROB	0,31335	0,42120	-0,03220	0,23412
	COLDIE	0,07365	0,40130	0,42520	0,30005
	CUOANT	-0,05949	-0,21907	0,15483	-0,04124
	DELCEL	-0,07943	-0,19979	-0,04952	-0,10958
	FEDALE	-0,27307	-0,13389	0,30204	-0,03497
	FERTOM	0,22803	0,36278	0,43867	0,34316
	MANANN	0,12063	-0,20665	-0,35743	-0,14781
	MANASS	0,50599	0,09694	0,21775	0,27356
	MIEMAR	-0,08881	0,04217	-0,16533	-0,07066
	MORDAN	-0,28303	0,54347	-0,16014	0,03343
	NATAND	0,21111	0,16988	0,09901	0,16000
	SILFED	-0,21120	0,29052	0,08705	0,05545
NS	ALFFAB	0,16860	0,19427	0,00967	0,12418
	AMOMIC	0,43305	0,55421	0,52297	0,50341
	AUTPAO	0,55482	0,33197	0,29370	0,39350
	AZZFLA	0,43322	0,39840	0,30841	0,38001
	BUZJAC	-0,38232	-0,25288	0,08524	-0,18332
	CAPAND	0,41786	0,23850	0,28168	0,31268
	DEPNOR	-0,35309	-0,28703	0,52539	-0,03824
	ESAFRA	-0,19433	-0,44805	-0,53989	-0,39409
	FLOCAR	-0,73692	-0,74702	0,09618	-0,46259
	GORSOF	0,67803	0,78640	-0,64647	0,27265
	LEGSAV	-0,01947	-0,22127	0,75752	0,17226
	MICCAT	-0,63732	-0,22901	-0,06253	-0,30962
	PASSER	0,75981	0,56480	0,49302	0,60588
	PUOCRI	-0,24168	-0,15843	-0,51298	-0,30436
	ROSFAB	0,10035	-0,22480	-0,01681	-0,04709
	SALANT	0,43062	0,57946	0,48193	0,49734
	SCAGAB	0,02623	0,34071	-0,37931	-0,00412
	SPADAV	0,45055	0,81444	0,11703	0,46067
	TRBANA	0,04679	0,22115	-0,09308	0,05828

TABLE V.3 | GFP z-score of approach-withdrawal index, of each participant, for each awarded PSA.

- **Mental Effort (Efl) index**

		GFP z-score Effective PSAs				
		Bubble wrap	***Smoking kid***	***Help.eu***	***CDC Roosevelt***	**MEAN**
HS	ALFROS	-0,60477	-0,30224	-0,40415	-0,44656	-0,60477
	ALIMIC	-0,50768	-0,26917	-0,48493	-0,42854	-0,50768
	AQULUI	0,00714	-0,37936	0,27041	-0,48339	0,00714
	ATTGIU	-0,47232	0,38308	0,44407	0,22877	-0,47232
	CALLAU	-0,39749	-0,54948	-0,48870	-0,41659	-0,39749
	CEKANN	-0,39952	-0,30307	-0,41350	-0,15156	-0,39952
	CHIFAB	-0,84541	-0,31483	-0,33178	-0,66489	-0,84541
	CIUROB	-0,24503	0,31396	0,68835	-0,06696	-0,24503
	COLDIE	-0,65942	-0,38836	-0,49809	-0,39311	-0,65942
	CUOANT	-0,35718	-0,56720	-0,53640	-0,29017	-0,35718
	DELCEL	-0,46364	-0,35613	-0,20970	-0,26208	-0,46364
	FEDALE	-0,24752	0,02868	0,17701	-0,05292	-0,24752
	FERTOM	-0,53184	-0,26857	-0,24252	-0,32410	-0,53184
	MANANN	-0,57604	-0,16726	-0,01208	-0,17997	-0,57604
	MANASS	-0,24516	0,01281	0,22422	0,21426	-0,24516
	MIEMAR	-0,56709	-0,46013	-0,37389	-0,49388	-0,56709
	MORDAN	-0,07219	1,78878	-0,17367	0,03217	-0,07219
	NATAND	-0,79242	1,05608	0,24045	0,30484	-0,79242
	SILFED	-0,74584	-0,17325	-0,34722	-0,44063	-0,74584
NS	ALFFAB	-0,95987	-0,29392	0,37833	-0,64174	-0,95987
	AMOMIC	-0,77947	-0,65813	-0,64476	-0,59821	-0,77947
	AUTPAO	-0,59070	-0,39904	-0,23112	-0,14735	-0,59070
	AZZFLA	-0,45202	0,48528	0,43195	0,29627	-0,45202
	BUZJAC	-0,06005	-0,03962	-0,15015	-0,04380	-0,06005
	CAPAND	-0,52805	-0,16472	-0,08884	0,02988	-0,52805
	DEPNOR	-0,44794	0,84463	0,87898	0,56001	-0,44794
	ESAFRA	-0,10056	0,30192	0,31827	-0,15535	-0,10056
	FLOCAR	-0,90545	-0,68327	-0,68829	-0,26698	-0,90545
	GORSOF	-1,07349	-0,63517	-0,73317	-0,75099	-1,07349
	LEGSAV	-0,56678	0,13333	-0,25633	0,20626	-0,56678
	MICCAT	-0,31423	0,17949	0,00168	0,05234	-0,31423
	PASSER	-0,53014	-0,23006	-0,58232	-0,54918	-0,53014
	PUOCRI	-1,13591	-0,48407	0,14287	-0,37401	-1,13591
	ROSFAB	-0,08737	-0,34081	-0,41199	-0,27549	-0,08737
	SALANT	-0,85877	-0,68219	-0,44877	-0,73608	-0,85877
	SCAGAB	-1,08415	0,70499	1,38661	0,41906	-1,08415
	SPADAV	-0,34142	0,60064	0,60159	0,21778	-0,34142
	TRBANA	-0,85819	-0,11025	-0,27526	0,17492	-0,85819

TABLE V.4 | GFP z-score of mental effort index, of each participant, for each effective PSA.

		GFP z-score Ineffective PSAs			
		Feel free	***Think don't***	***Tobacco***	**MEAN**
HS	ALFROS	-0,16081	-0,30726	0,13104	-0,11235
	ALIMIC	0,30534	-0,38940	0,26629	0,06074
	AQULUI	1,27339	0,73272	1,43691	1,14767
	ATTGIU	2,11759	0,02505	-0,03973	0,70097
	CALLAU	-0,35867	0,61320	0,10073	0,11842
	CEKANN	-0,27708	-0,48501	-0,31380	-0,35863
	CHIFAB	-0,31691	-0,38587	-0,48362	-0,39547
	CIUROB	-0,16933	-0,35228	-0,56043	-0,36068
	COLDIE	0,56492	0,53790	0,14241	0,41507
	CUOANT	0,21987	-0,26962	-0,54963	-0,19980
	DELCEL	0,65759	0,27986	-0,20531	0,24405
	FEDALE	-0,10478	-0,29802	-0,33096	-0,24459
	FERTOM	-0,00782	-0,09465	-0,02581	-0,04276
	MANANN	-0,07158	0,02277	-0,05529	-0,03470
	MANASS	-0,58767	-0,35487	0,00035	-0,31406
	MIEMAR	0,50111	0,43981	-0,16050	0,26014
	MORDAN	0,18244	0,08116	-0,21453	0,01636
	NATAND	1,14462	0,57841	-0,10489	0,53938
	SILFED	-0,12473	0,98951	-0,16093	0,23462
NS	ALFFAB	0,10860	0,30546	-0,21905	0,06500
	AMOMIC	-0,66921	-0,45022	-0,53516	-0,55153
	AUTPAO	0,37433	0,15927	-0,31866	0,07165
	AZZFLA	1,03747	0,61037	0,54744	0,73176
	BUZJAC	0,38359	0,18783	-0,43798	0,04448
	CAPAND	0,69028	-0,01525	0,06339	0,24614
	DEPNOR	-0,13618	1,32496	0,48920	0,55933
	ESAFRA	-0,07852	0,63443	0,02786	0,19459
	FLOCAR	0,42406	-0,30378	-0,63868	-0,17280
	GORSOF	-0,66318	-0,39652	-0,88973	-0,64981
	LEGSAV	-0,06165	-0,22131	-0,11467	-0,13254
	MICCAT	0,65898	0,11883	0,28749	0,35510
	PASSER	-0,24139	-0,31632	-0,56186	-0,37319
	PUOCRI	-0,20465	0,89768	-0,52277	0,05675
	ROSFAB	0,06197	-0,18396	0,22070	0,03290
	SALANT	-0,14047	-0,67454	-0,41828	-0,41110
	SCAGAB	1,09930	0,54207	0,01372	0,55170
	SPADAV	1,05928	0,89050	0,28708	0,74562
	TRBANA	0,51123	0,58366	-0,09119	0,33456

TABLE V.5 | GFP z-score of mental effort index, of each participant, for each ineffective PSA.

		GFP z-score Awarded PSAs			
		Fatty cigarettes	***Baby love***	***Breath holder***	**MEAN**
HS	ALFROS	-0,57869	-0,54981	-0,39069	-0,50640
	ALIMIC	-0,67963	-0,84292	0,48483	-0,34591
	AQULUI	-0,29283	-0,15981	-0,17879	-0,21047
	ATTGIU	0,03525	-0,20543	0,54022	0,12335
	CALLAU	-0,45651	-0,56856	-0,20728	-0,41078
	CEKANN	-0,22908	-0,11018	-0,35905	-0,23277
	CHIFAB	-0,70413	-0,92852	-0,34204	-0,65823
	CIUROB	-0,60769	-0,23645	0,25428	-0,19662
	COLDIE	-0,56303	-0,56126	-0,45270	-0,52566
	CUOANT	-0,50856	-0,77576	-0,60012	-0,62815
	DELCEL	-0,09741	-0,13459	0,48178	0,08326
	FEDALE	-0,51325	-0,37079	0,04407	-0,27999
	FERTOM	-0,03966	-0,06218	-0,04939	-0,05041
	MANANN	-0,35837	-0,16447	-0,33496	-0,28593
	MANASS	-0,20064	-0,44633	-0,24053	-0,29583
	MIEMAR	0,09852	-0,30328	0,34144	0,04556
	MORDAN	-0,63741	-0,53405	-0,53446	-0,56864
	NATAND	-0,21103	-0,55445	-0,36980	-0,37843
	SILFED	-0,41088	-0,07589	-0,29347	-0,26008
NS	ALFFAB	-0,61115	-0,69489	0,23177	-0,35809
	AMOMIC	-0,70015	-0,74400	-0,57943	-0,67453
	AUTPAO	-0,43474	-0,21634	-0,26110	-0,30406
	AZZFLA	-0,02267	-0,05631	0,29796	0,07300
	BUZJAC	-0,37681	-0,21976	-0,00738	-0,20132
	CAPAND	-0,34219	-0,22522	-0,11718	-0,22820
	DEPNOR	0,28529	0,50353	-0,44774	0,11369
	ESAFRA	-0,39726	-0,10960	0,87859	0,12391
	FLOCAR	-0,82945	-0,64502	0,09846	-0,45867
	GORSOF	-0,79476	-0,82884	-0,72429	-0,78263
	LEGSAV	-0,16336	0,00803	-0,78076	-0,31203
	MICCAT	-0,24669	-0,11559	0,52839	0,05537
	PASSER	-0,83751	-0,56628	-0,43146	-0,61175
	PUOCRI	-0,62733	-0,22369	-0,77402	-0,54168
	ROSFAB	-0,51994	-0,10185	-0,37461	-0,33214
	SALANT	-0,78481	-0,62711	-0,16442	-0,52545
	SCAGAB	0,33703	-0,03173	0,64866	0,31799
	SPADAV	0,21521	0,56335	0,19398	0,32418
	TRBANA	-0,58867	-0,65959	-0,12175	-0,45667

TABLE V.6 | GFP z-score of mental effort index, of each participant, for each awarded PSA.